HEAVY MINERALS OF THE CATAHOULA OF FAYETTE COUNTY, TEXAS

Approved:

Approved:

Dean of the Graduate School.

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HEAVY MINERALS OF THE CATAHOULA OF FAYETTE COUNTY, TEXAS

THESIS

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MASTER OF ARTS

By

Arno Paul Wendler, B. A.
(Ledbetter, Texas)
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HEAVY MINERALS OF THE CATAHOULA OF FAYETTE COUNTY, TEXAS

CHAPTER I

INTRODUCTION

Purpose

The purpose of this work is to make a study of the Catahoula formation of Fayette County, Texas, as to lithology, heavy mineral content, correlative horizons, and paleogeography. The technique of heavy mineral separations, thin-sectioning of the softer materials, and the mounting of the heavy concentrates will also be described and discussed.

Location

The formation under consideration is in Fayette County, Texas, and outcrops in a belt from one to five miles wide extending through the county in a northeasterly direction.

Fayette County, Texas, is bounded on the north by Lee County; on the east by Washington, Austin, and Colorado counties; on the south by Lavaca County; and on the west by Gonzales, Caldwell, and Bastrop counties. LaGrange, the county seat of Fayette County, is about 100 miles west of Houston.

Four railroads run through Fayette County. The Houston and Texas Central Railroad extends through the northern part of the county; the Missouri, Kansas and Texas Railroad, which runs through LaGrange, practically parallels the Colorado River, dividing the county into two equal parts. The Southern Pacific Railroad, which parallels the southern boundary of the county, runs through Flatonia and Shulenburg. The San Antonio and Aransas Pass Railroad extends through the western part of the county, intersecting with the Missouri, Kansas and Texas Railroad at West Point, a little town in the west central part of the county.

Federal Highway No. 90, known as the Old Spanish Trail, in the southern part of the county runs through Shulenburg and Flatonia. State Highways Nos. 71 and 72, connecting at LaGrange, run through the central part of Fayette County, the latter intersecting Highway No. 20 at Carmine. Highway No. 20 runs in an east-west direction, crossing the northern tip of Fayette County, passing through Carmine and Ledbetter.

Acknowledgements

The writer is indebted to Dr. Fred M. Bullard, Chairman of the Department of Geology of the University of Texas, who suggested a subject dealing with heavy minerals, and for advice and helpful suggestions he gave concerning this work.

To Mr. Leslie Bowling for the aid he gave the writer and for the many suggestions he made in regard to this work.

To Mr. R. D. Woods who acquainted the writer with the different phases of technique required for this work.

To Mr. F. W. Rolshoussen of the Humble Oil and Refining Company of Houston, and to Mr. J: Garst of the Continental Oil Company of Mexico, who furnished the writer with samples from the Catahoula of

Austin County and Northern Mexico respectively. To these men the writer extends his full appreciation in return for the services they have rendered.

Drainage and Physiography

The Colorado River flows in a meandering course to the southeast through the central part of the county. At LaGrange the course of the stream is deflected considerably before it finally cuts through the sandstone and clay escarpment of the Oakville. Mention is made of the Oakville series of clays and sandstones in this part of the paper because it determines the courses of the minor drainage and to some extent influences the major drainages. Cummins Creek, in the northern part of the county, cuts through the Oakville escarpment at Round Top without being deflected, probably because of the softness of the sandstones in this particular part of the county. Cedar Creek, flowing to the southwest and into the Colorado River just south of LaGrange, is quite obviously a strike-stream. Buckner's Creek, the major drainage of the central-western part of the county, flows southeast until it encounters the sand escarpment, then makes a right angle turn to the northeast. Other minor drainages of the area are tributaries to these three major creeks or to the Colorado River.

Topography of the formation under discussion, the Catahoula, consists of very low flat hills, frequently arranged along the strike of the beds. Compared with the Oakville escarpment, the hills of the

Catahoula in Fayette County are flat, low, and inconspicuous.

General Stratigraphic Position of the Catahoula in the Tertiary Section of the Gulf Coast

The chart, Plate I, is a generalized section of the Tertiary as given by Deussen[1] with a few changes by the writer.

(The writer is well aware of the fact that many subsequent changes have been made in this section. However, it gives the reader an idea of the position of the Catahoula in the Tertiary section.)

Correction:
Mr. Mc Neil worked ~~with the~~ this fauna but he did not give its age.

The Catahoula of Fayette County, Texas, is lower Miocene in age as determined by F. S. McNeil.[2] Deussen placed the Catahoula in the Oligocene, but in view of more recent work it now appears that the Oligocene is absent in this part of Texas.

The Catahoula Formation

The Catahoula sandstone was named by Veatch in 1906 from Catahoula Parish, Louisiana.[3]

In 1918 Dumble[4] described and mapped the Corrigan (Catahoula) in East Texas, east of the Brazos River.

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[1]Deussen, Alexander: "Geology of the Coastal Plain of Texas, West of the Brazos River," U. S. Geol. Sur. Prof. Paper, 126, 1924, pp. 21-22.

[2]Mr. F. S. McNeil, of the U. S. National Museum, Washington, D. C., identified fauna collected by Mr. Leslie Bowling in the lower part of the Catahoula about 3 miles south of Nechanitz in the northern part of Fayette County, Texas.

[3]Veatch, A. C.: "Geology and Underground Water Resources of Northern Louisiana and Southern Arkansas," U. S. Geol. Sur. Prof. Paper, 46, pp. 42-43, 1906.

[4]Dumble, E. T.: "The Geology of East Texas," University of Texas Bull., No. 1869, 1918, pp. 187-218.

GENERALIZED SECTION OF THE TERTIARY OF THE GULF COAST SHOWING THE POSITION OF THE CATAHOULA

CENOZOIC	QUATERNARY	Recent	Recent
		Pliestocene	Beaumont Clay
			Lissie Gravel
	TERTIARY	Pliocene	Unconformity
			Reynosa
			Unconformity
			Lagarto
		Miocene	Oakville Sandstone
			Catahoula Sandstone ?
		Oligocene	Absent
		Eocene	Frio Clay--Jackson
			Fayette Sandstone
			Yegua
			Cook Mountain
			Mt. Selman
			Unconformity
			Carrizo Sand
			Unconformity
			Wilcox (Indio)
			Midway
MESOZOIC	CRETACEOUS		

The Corrigan (Catahoula) of East Texas, according to Dumble,[5] is a term synonymous with the Catahoula as named by Veatch. The basal Corrigan (Catahoula) consists of a series of massive coarse-grained to fine-grained sandstones inter-bedded with volcanic tuffs, clays, and lignites. These sands lie unconformably upon the upper Jackson (Fayette) which consists of fossiliferous unconsolidated, medium-grained, drab-grey sandstone and chocolate colored fossiliferous shale. The upper Corrigan (Catahoula) consists of limey clays, tuffs, and thin lentils of coarse to medium-grained sandstones. Dumble calls this upper series the Onalaska.

The Onalaska beds were named after the little town of Onalaska in western Polk County where these clays are characteristically exposed. These beds are similar to the overlying Fleming strata in lime content, but otherwise are predominantly the same greenish, hackly-fractured, conchoidal, or whitish materials, impregnated with large nodules and flat seams of secondary lime, and lenses of sandstone and claystone.[6]

The Onalaska beds are predominantly clays with numerous sandstone lentils, while the lower member of the Corrigan (Catahoula) consists chiefly of massive sandstones interbedded with thin horizons of clays and tuffaceous sediments. The basal Corrigan (Catahoula) outcrops in a band about three miles wide. To the southwest, however, it either

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[5] Op. cit., pp. 188-189.
[6] Observations by the author while working in East Texas for the Gulf Production Company in the summer of 1929.

thins considerably or changes laterally into softer sediments, because at the Walker-Grimes county line, about thirty miles east of the Brazos River, the massive horizons are replaced by thin,hard blue quartzose sand beds which merge into the lower more impure, locally fossiliferous, less indurated Jackson (Fayette) sands.

General Stratigraphy of the Catahoula of Fayette County, Texas

The Catahoula southwest of the Brazos as described by Deussen[7] and observed by the author[8] has lost nearly all of its massive Corrigan sandstone, (basal Catahoula of East Texas) horizons.

Extent of the Catahoula in Fayette County, Texas

The Catahoula outcrop enters Fayette County, Texas, on the north between Carmine and Ledbetter in the northern part of the county. It then extends southwestward through the LaGrange area, then southwestward through Flatonia in the southwestern part of the county, crossing the Gonzales-Fayette county line two miles south of Flatonia.

The upper Jackson (Fayette) consists of sands, ashy horizons, and chocolate colored shale horizons. In places, especially in the southern part of the county, the Jackson (Fayette) rocks are quite similar to the Catahoula above so that in some places it is difficult to tell them apart. Such characteristics as bedding, argillaceous content,

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[7] Deussen, A.: "Geology of the Coastal Plain of Texas West of the Brazos River," U. S. Geol. Surv. Prof. Paper 126, 1924, pp; 100-102.

[8] Noticed while assisting Mr. Leslie Bowling in mapping the outcrop of the Catahoula through Fayette County, Texas.

isolated ash horizons, brown chocolate colored shale beds, and extremely fine-grained, drab-colored, unconsolidated sands distinguish the Jackson from the more pyroclastic Catahoula. Macroscopically, however, the ash beds of the Jackson are similar in every respect to the ash of the Catahoula. Lignite beds were found in the upper Jackson (Fayette), but none were observed in the Catahoula.

The lower Oakville consists of brown, buff, gray, and red limey clays interbedded with coarse-grained limey sands, often fifteen to twenty ~~inches~~ Feet thick. Often these basal sands contain fifty per cent lime or coquina debris. Disintegrated lime nodules have a tendency to blacken the soil, which becomes sticky and gummy when wet. The nodular lime is apparently of secondary origin, precipitated out of saturated lime waters, which migrated through the basal Oakville sands.

All upper Miocene sediments in this part of the Texas Coastal Plain are characteristically limey. Some of the nodules are quite hard; others are merely lumps of white powder.

Detailed Stratigraphy of the Catahoula of Fayette County, Texas

The Catahoula of Fayette County, Texas, consists chiefly of ash, ashy clays, white clays, green nodular and hackly-fractured clays, claystones and thin beds of medium-grained sandstone. The basal sand member in the northern part of the county consists locally of quartzose sandstone. This is probably the beginning of the Corrigan sand (basal Catahoula of East Texas) of the East Texas section.

Section 1, Fig. 1, Plate II: This section was taken $1\frac{1}{2}$ miles south of Flatonia at right angles to the strike of the Catahoula on the San Antonio and Aransas Pass Railroad on the west corner of the Geo. W. Cottle Survey on the W. M. Nollkamper and F. Valenka tracts.

As the diagram shows, Oakville sediments lie directly upon the Jackson (Fayette), completely covering the Catahoula. However, creeks cutting through the thin veneer of Oakville expose the Catahoula which consists mainly of green, homogeneous, conchoidal clays and loosely cemented impure, clayey sands.

The upper Jackson (Fayette) in this area consists of laminated fine-grained sands, ash stringers, and chocolate-brown, somewhat lignitic shales.

The Oakville consists of coarse-grained, limey, cross-bedded sands and buff, brown, and grey clays impregnated with lime nodules.

Section 2, Fig. 2, Plate II: This section was taken along the S. E. line of the E. Y. Kean Survey, 320 acres, extending eastward into the T. O. Berry League, about three miles east of Muldoon on the LaGrange-Flatonia road. A lense of colvanic ash consisting of pure glass is found at the top of the Jackson (Fayette) in this section. The glass consists of large shreds of isotropic fragments which are full of blow holes. Otherwise the upper Jackson (Fayette) consists of the same shale and sands described in Section 1.

Two ash beds in the Catahoula were mapped at this locality. Above

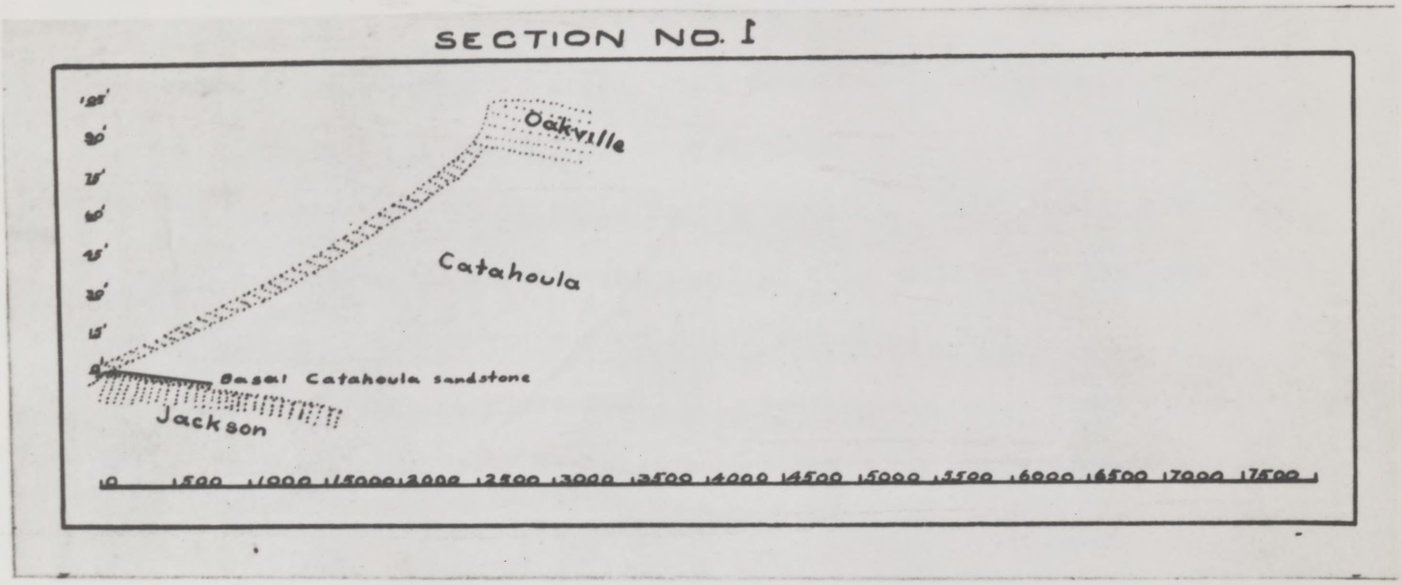

Fig. 2. Section $1\frac{1}{2}$ miles south of Flatonia, at right angles to the strike of the Catahoula on the S. A. & A. P. R. R. in the west corner of the Geo. W. Cottle League on the W. M. Nollkamper and F. Valenka tracts.

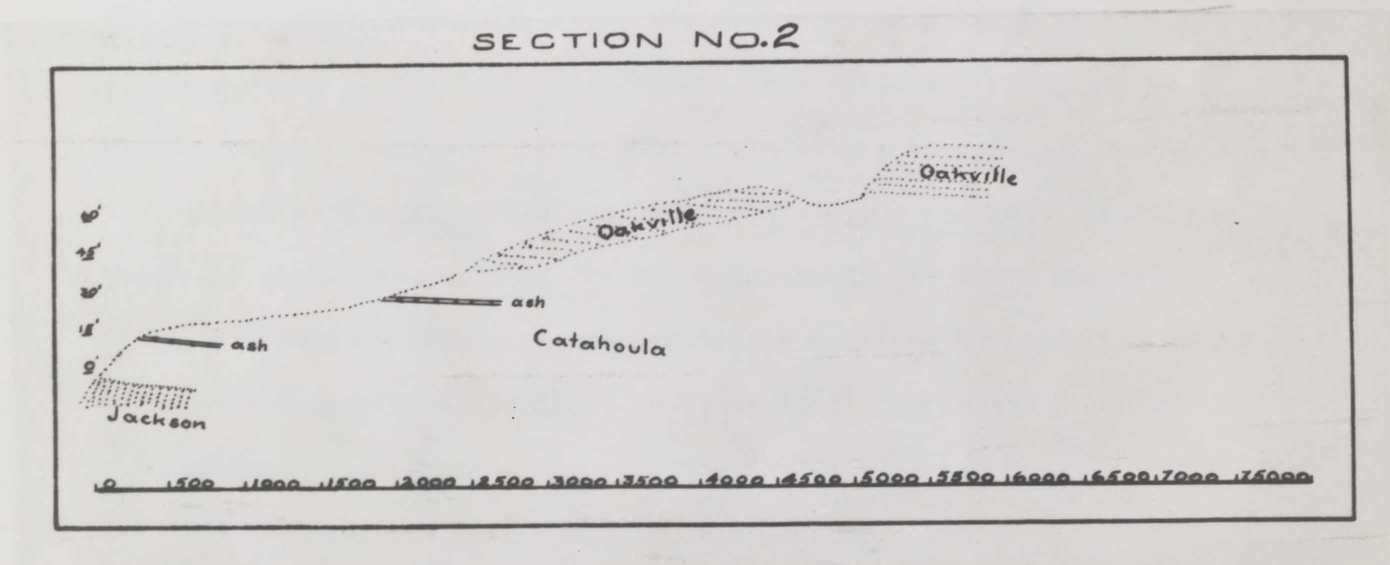

Fig. 3. Section along the S. E. line of the E. Y. Kean League, 320 Ac., extending eastward into the T. O. Berry League about 3 miles east of Muldoon on the La Grange-Flatonia road.

and below these two members green, hackly-fractured, and greenish to white, conchoidal, tuffaceous clays predominate.

An Oakville overlap is shown in this section. This overlap disappears rapidly to the north. The sands in this section are the same limey, coarse to medium-grained materials described above.

Section 3, Fig. 4, Plate III: This section was taken about three miles south of LaGrange in the west central part of the David Berry League southeast of Buckner's Creek.

No Jackson (Fayette) was mapped in this section.

The Catahoula is characterized by two distinct ash horizons, ashy sands, tuffaceous clays, and locally cemented sand horizons.

The Oakville sands above the Catahoula are coarse-grained and cross-bedded similar to those described above.

Section 4, Fig. 5, Plate III: This section was taken in the northern part of Fayette County, about one mile west of Waldeck along the southwest line of the W. T. Williamson, John Vanderworth, and R. G. Baugh Leagues. Exposures along this traverse are exceedingly poor.

A laminated sandy shale constitutes the upper Jackson. Usually a quartzose sandstone, marking the basal Catahoula, is found directly above this sandy shale. In this particular section, however, the sandstone is not present although it is found to the north and south of this point.

Two ash beds are persistent in this section.

The Oakville consists of thin sandstone lentils interbedded with massive beds of brown, buff, to gray limey clays.

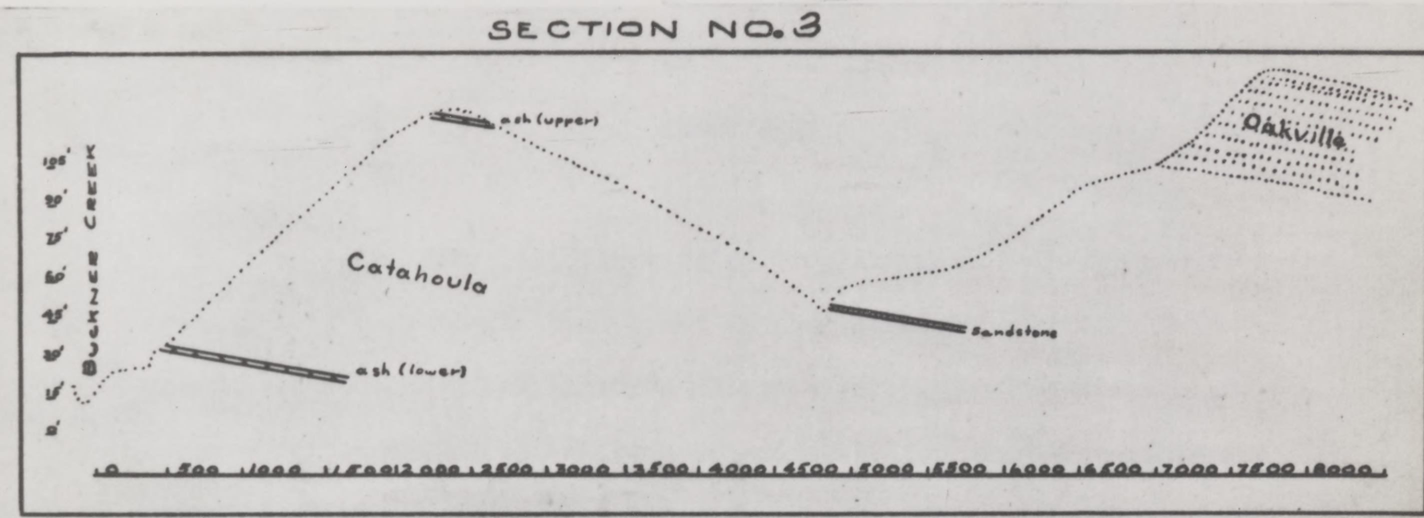

Fig. 4. Section about 3 miles south of La Grange in the west central part of the David Berry League southeast of Buckner's Creek.

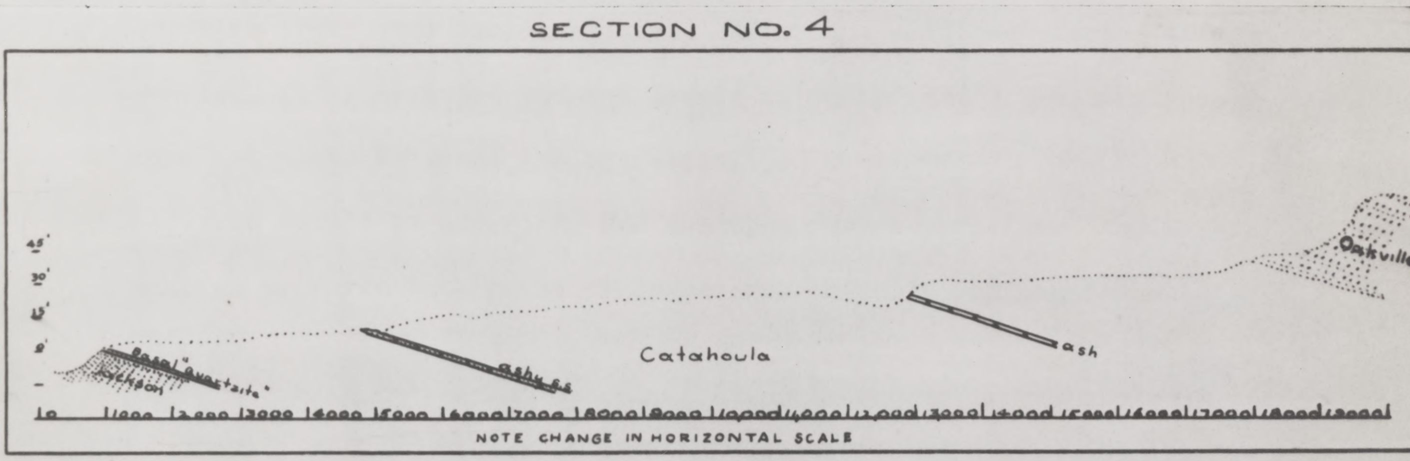

Fig. 5. Section in the northern part of Fayette County, about one mile west of Waldeck along the southwest lines of the W. T. Williamson, John Vanderworth, and R. G. Baugh Leagues.

CHAPTER II

TECHNOLOGY

The chart, Plate IV, illustrates diagramatically the procedure used in the mineralogical analysis of the Catahoula samples. This chart was modeled after Milner's[8] diagram entitled: "Systematic procedure for simultaneous analysis of sediments for micro-organisms and minerals." Since the Catahoula of Fayette County has no micro-organisms, the chart is simplified from Milner with some additions by the writer.

Heavy Mineral Separation

Before bromoform can be applied in the separation of the heavy minerals from the light minerals, the sample to be run must be subjected to a few preliminary tests. First, after the rock is crushed, if consolidated, the sample is treated with about a 50% solutiom of HCL in order to break down the carbonates. After the acid has stopped effervescing, it is decanted and the sample is washed and dried, preferably on a hot plate to speed the operation.[9]

The sample is now ready for the bromoform separation. About forty samples were run to a pound of bromoform. Methods and suggestions given

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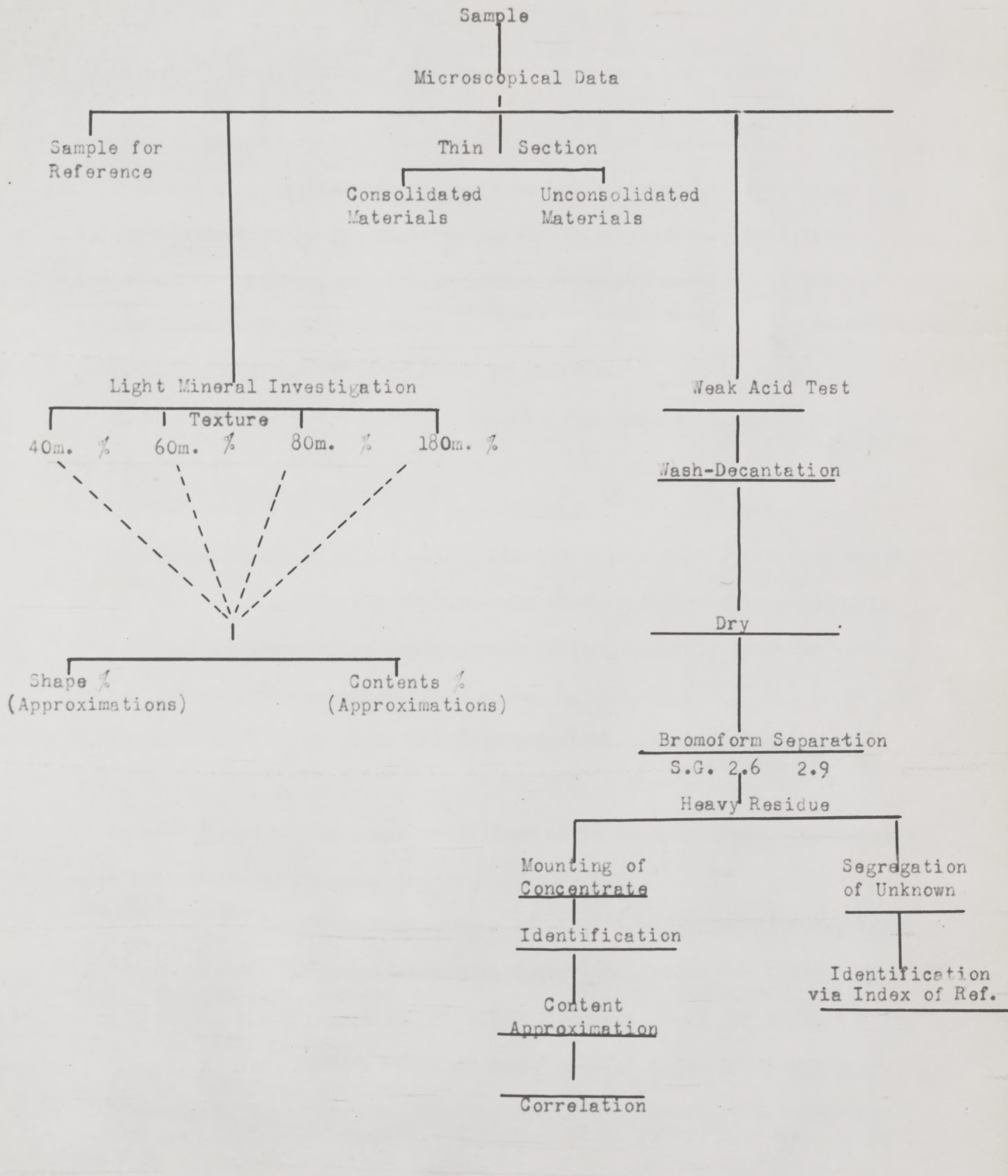
[8] Milner, H. B.: "Sedimentary Petrography," London, 2nd Edition, 1929, pp. 39-43.

[9] Edson, F. C.: "Criteria for the Recognition of Heavy Minerals Occurring in the Mid-Continent Field," Okla. Geol. Surv., Bull., 31, 1925, p. 6.

Systematic Procedure for Analysis of the Catahoula Sediments for Heavy Minerals



by Milner,[10] Ross,[11] Reed,[12] and Edson[13] were used and followed.

Laboratory Procedure Used in Bromoform Separations

In the diagram Plate V, Milner's method of bromoform separation is shown except for a few minor details. This apparatus, as illustrated in the diagram, and the following procedure was used in the separations:

1. Set up the apparatus as shown in diagram.

2. Pour bromoform (O) into top funnel (B). Take care and do not spill.

3. Pour in cleaned sample to be separated.

4. Stir with stirring rod (L). Stir the liquid with a rotating movement. This will make the heavy minerals that are below 2.7 in specific gravity settle towards the center, many falling directly into the vent of the funnel without touching the sides.

5. Cover with watch glass (P) to prevent evaporation of the bromoform.

6. Repeat the stirring operation from three to four times, depending upon the nature of the sample.

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[10] Milner, H. B.: "Sedimentary Petrography," London, 2nd Edition, 1929, pp. 39-43.

[11] Ross, G. S.: "Preparation of Sedimentary Materials for Study," Econ. Geol., 21, 1926, pp. 455-460.

Ross, C. S.: "Preparation of Sedimentary Materials for Study," Econ. Geol., 23, 1928, p. 334.

[12] Reed, R. D.: "Some Methods of Heavy Mineral Investigation," Econ. Geol., 19, 1924, pp. 326-327.

[13] Edson, F. C.: "Criteria for the Recognition of Heavy Minerals Occurring in the Mid-Continent Field," Okla. Geol. Surv., Bull. 31, 1925, pp. 6-7.

7. Take beaker (K), place or hold it under rubber tube (D), open clamp (E) and let out the heavy concentrate with some of the clear bromoform.

8. Give the beaker with the bromoform and concentrate a swinging rotary movement. Nearly all light minerals that have come through with the bromoform will cling to the walls of the beaker; the heavy concentrate will settle to the bottom.

9. Decant the bromoform into filter (G); tie rag around finger or a glass rod and wipe off the light minerals adhering to the beaker walls.

10. Wash the concentrate with benzol to dissolve the bromoform adhering to the grains, decant the benzol and let the concentrate dry.

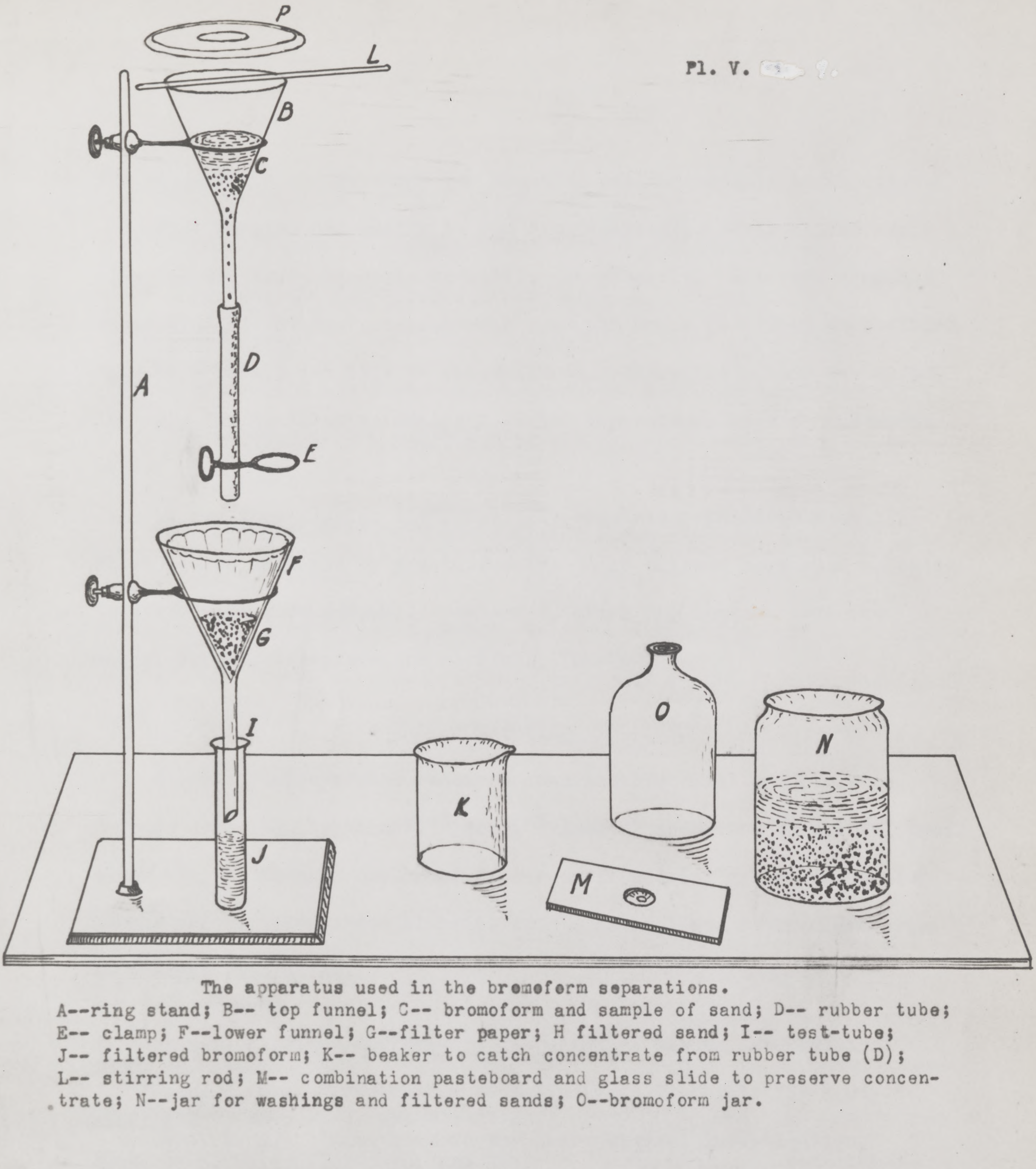
11. In the meantime let the remaining bromoform and sands run into funnel (F) and filter paper. The bromoform will filter through and run into test tube (J). This bromoform may be used again.

12. After the bromoform has filtered from the sands (H), drop sand into wash bottle (N); wash used filter with benzol and discard.

13. Reset apparatus; scrape adhering sands out of top funnel (b) into wash-bottle (N) and wash the funnel with benzol. Water does not evaporate fast enough for continuous successive operations. Take rubber tube (D) stretch it several times making sure all grains of sand are removed; reset clamp (E); put new filter paper into funnel (F); take used bromoform in test tube (J) and use again.

14. After concentrate in beaker (K) has thoroughly dried, put the material into receptacle of the combination pasteboard glass slide (M).

Pl. V.



The apparatus used in the bremeform separations.
A--ring stand; B-- top funnel; C-- bromoform and sample of sand; D-- rubber tube; E-- clamp; F--lower funnel; G--filter paper; H filtered sand; I-- test-tube; J-- filtered bromoform; K-- beaker to catch concentrate from rubber tube (D); L-- stirring rod; M-- combination pasteboard and glass slide to preserve concentrate; N--jar for washings and filtered sands; O--bromoform jar.

The concentrate is now ready for mounting and microscopic examination.

Four samples can easily be run simultaneously. This allows ample time for the heavy minerals to settle out properly. However, complete separation of the heavy concentrate from the sands is almost impossible. Only very rarely can this be accomplished. Since the author was striving only for qualitative analysis, total separations were not so pertinent.

To run four samples simultaneously requires considerable skill, which can be acquired by practice only. Also extreme care must be taken to avoid mixing of samples. Beakers in which the concentrates are caught should, therefore, be carefully labeled.

Mounting

Mounting concentrates requires considerable skill and patience. Methods described by Milner,[14] Ross,[15] Reed,[16] and Edson[17] were followed. After all, to mount a number of rather small mineral grains in Canada Balsam and to cover these minerals with a cover glass of standard type is a simple operation.

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[14] Milner, H. B.: "Sedimentary Petrography, London, 2nd Edition, 1929, pp. 44-45.

[15] Ross, C. S.: "Preparation of Sedimentary Materials for Study," Econ. Geol., xxi, 1926, pp. 454-468.

[16] Reed, R. D.: "Some Methods for Heavy Mineral Investigation," Econ. Geol., xix., 1924, pp. 320-327.

[17] Edson, F. C.: "Criteria for the Recognition of Heavy Minerals Occurring in the Mid-Continent Field," Okla. Geol. Surv., Bull. 31, 1925.

The following is the writer's procedure:

1. Pour minerals out of combination pasteboard glass slide onto clean white paper, filter paper preferable.

2. Crease paper to form a sort of trough.

3. Take clean glass slide of standard type and drop enough minerals from the filter paper on the slide to make a representative concentrate for examination.

4. Drop raw balsam on the concentrate, place slide on hot plate, and heat slowly.

5. While balsam is being heated, take hot needle and stir the concentrate in the balsam slowly. Bubbles, which are liable to form between the minerals when the balsam is poured on the concentrate and slide, will be removed by the stirring.

6. Heat balsam to semi-hardness. The test for semi-hardness is as follows: Take cold needle, dip into hot balsam on hot slide; dip needle with adhering balsam into cold water. If the balsam is hard enough,, the bead on the point of the needle can be indented with a finger nail without either sticking or cracking. Never heat balsam to brittleness.

7. Take slide off the hot plate, cool, and inspect concentrate under microscope with ordinary light for bubbles and condition of concentrate.

8. The mount is now ready for covering. Place the slide with semi-hardened balsam and minerals crop again on hot plate; take a standard cover glass; clean it carefully, and warm it on the hot plate.

9. As soon as balsam is hot enough, drop one end of cover glass into

the balsam; hold cover glass in a tilted position with needle; lower it gradually, making sure that it makes an equal contact with the balsam as it is gradually lowered.

10. If bubbles have formed during the lowering process, maneuver the cover glass around with the needle. Generally, all bubbles can be extracted in this manner.

11. Remove slide from hot plate and let cool. Scrape surplus balsam off with a razor blade, wash slide with xylol, and label fully.

Identification

Identification of heavy minerals requires considerable knowledge of microscopic petrography. Often single concentrates were found to contain as many as fifteen minerals. The rarer varieties are often small and difficult to identify, as many of their optical properties cannot be determined.

By far the most outstanding work on detritals is that by Milner.[18] Larsen,[19] and Weinschenck and Clark[20] were also referred to. Finally, a collection of slides of detrital minerals in the petrography laboratory of the University of Texas was used extensively.[21]

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[18] Milner, H. B.: Sedimentary Petrography, London, 2nd Edition, 1929, pp. 116-263.

[19] Larsen, E. S.: "The Microscopic Determination of the Non-Opaque Minerals," U. S. Geol. Surv., Bull. 679.

[20] Weinschenck, E. and Clark, R. W.: Petrographic Methods, New York, 1912, pp. 213-341.

[21] These slides contain the common detritals, and were obtained from Thos. Murby & Co., London, England.

As stated above, minerals in concentrates are difficult to identify because of the few optical properties available. Hence, for every concentrate that was mounted, a part of the mineral crop was retained to be used for the determination of the index of refraction. A set of standard media with known index of refraction was used.[22]

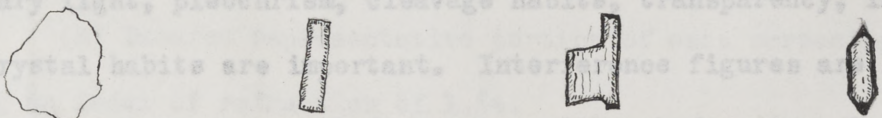
The procedure used in the determination of the index of refraction by the oil-immersion method is quite simple. The Backe method was found to be the most satisfactory.[23]

Procedure:

1. With a fine needle pick out unknown fragment to be examined and place on clean dry slide.

2. Drop oil with index of refraction of 1.54 on mineral in order to estimate its relative index of refraction. Approximate the index of refraction of the unknown by the amount of relief the mineral shows immersed in oil. This is merely a matter of guessing; however, fairly accurate results can be obtained.

Quartz Tourmaline Kyanite Zircon



A B C D

Fig. 1.--Showing sketches of Quartz (A), Tourmaline (B), Kyanite (C), and Zircon (D) as they appear immersed in oil.

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[22] Tickell, F. G.: Examination of Fragmental Rocks, 1931, pp. 57-59.

[23] Weinschenck, E. and Clark, R. W.: Petrographic Methods, New York, 1912, pp. 33-35.

Quartz, tourmaline, kyanite, and zircon were used in estimating the index of refraction of the unknown mineral because they are easily recognized and are widespread in occurrence. Under ordinary light these minerals have the following distinctive features:

Quartz, no relief--1.54

Tourmaline, medium relief--1.64

Kyanite, high relief plus narrow black band on the outer border of the mineral--1.71

Zircon, high relief plus wide intensely black band on outer border--over 1.80, and usually definite pyrimidal faces.

3. Place unknown mineral, after its index of refraction has been estimated, in oil slightly lower or higher in index of refraction as the case may have been in the estimation, and thus determine the exact index of refraction of the unknown.

The above method is very satisfactory. All other optical properties that are determinable must be used, such as color of mineral in ordinary light, pleochrism, cleavage habits, transparency, inclusions, and crystal habits are important. Interference figures are hard to obtain, especially on small fragments, although few minerals, such as biotite, calcite, and muscovite, give very satisfactory figures. The work by Milner,[24] who described fifty-five of the common detritals, and the works by Weinschenck and Clark[25] and Larsen[26] who give tabu-

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[24] Milner, H. B.: Sedimentary Petrography, London, 1929, pp. 116-263.

[25] Weinschenck, E. and Clark, R. W.: Petrographic Methods, New York, 1912, pp. 341-384.

[26] Larsen, E. S.: "The Microscopic Determination of the Non-Opaque Minerals," U. S. G. S., Bull. 679.

lated optical properties of practically every mineral known, were used.

Determination of the Abundance of Heavy Minerals

No percentage approximations were made. Seemingly, the standard terms used in determination of relative amounts of each mineral present are as follows: abundant (A), common (C), rare (R).[27]

Light Mineral Investigation

Quartz, feldspar, and feldspar alteration constitute the bulk of the light minerals found in the Catahoula of Fayette County. Forty-five tests were run on the light minerals using the method given below:

1. Use about 30 grams of material, wash it, and decant the flocculent materials.

2. Dry on hot plate.

3. Screen through standard set of screens.

4. Weigh or volumetrically determine the relative percent of the different screenings. Tabulate results and file for future reference.

5. Examine each screening under microscope.

(a) Immerse representative portion of each screening in medium having an index of refraction of 1.54.

(b) Cover temporarily with standard cover glass.

6. With the aid of a mechanical stage estimate the relative amounts of angular, sub-angular, sub-rounded, and rounded grains present.

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27 Lonsdale, J. T.; Metz, M. S.; and Halbouty, M. T.: "The Petrographic Characters of Some Eocene Sands from Southwest Texas," Journ. Sed. Pet., Vol. 1, 1931, pp. 73-81.

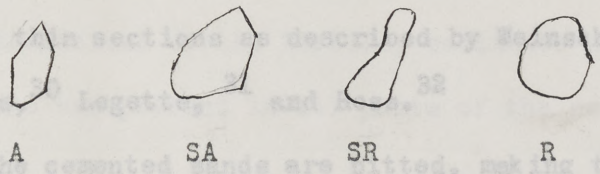

Fig. 2.--Diagrams showing shape criteria used, A--angular, SA--subangular, SR--sub-rounded, and R--rounded.

The above diagrams show and qualify shape criteria used in this investigation.

7. Finally, determine the relative light mineral content of each screening.

(a) Distinguish between quartz and feldspar grains and estimate relative amounts of each present.

(b) Notice the alteration products--kind and intensity.

(c) Make note of the amounts of both zircon and magnetite present.

This investigation was carried on for correlative purposes only. Although the author realizes that the results obtained are tentative, because of the limited number of samples investigated, a few facts were obtained and several tentative conclusions were reached.

Thin Sections

Rocks of the Catahoula in Fayette County are mostly friable ashes, clays, and unconsolidated sands with the exception of the basal quartzose sandstone which is well indurated. Standard laboratory technique was used in making thin sections as described by Weinschenck and Clark,[28] Milner,[29] Keyes,[30] Legette,[31] and Ross.[32]

Many of the cemented sands are pitted, making them extremely difficult to thin-section. Enough sections were made, however, to permit a comprehensive study of these sands.

The unconsolidated materials, such as the ashes, clays, and claystones of the Catahoula and the shales and Fuller's earth samples, were impregnated with either Canada Balsam or Kollilith.[33]

The author feels that locally horizon correlation is possible. The work done for this paper, however, is not sufficient to make any definite determinations. Thoroughness and systematic procedure applied to horrizons to be correlated will most assuredly bring satisfactory results.[34]

Factors that should be considered in a problem involving correlation of different beds are as follows: the amounts of different minerals present; degree of rounding; kinds of minerals present, whether resistant or non-resistant to the chemical and physical forces of nature; size;

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[28] Weinschenck, E. and Clark, R. W.: Petrographic Methods, New York, 1912, p. 146.

[29] Milner, H. B.: Sedimentary Petrography, London, 1929, pp. 35-36.

[30] Keyes, M. G.: "Making Thin Sections of Rocks," Amer. Journ. Sci., (5), 10, 1925, pp. 538-550.

[31] Legette, M.: "Preparation of Sections of Friable Rocks," Journ. Geol., 36, 1928, pp. 549-557.

[32] Ross, C. S.: "Preparation of Sedimentary Materials for Study," Econ. Geol., 21, 1926, pp. 454-468.

[33] A cementing medium manufactured by Voigt and Hochgesang of Germany.

[34] Heald, K. C.: "Study and Correlation of Sediments by Petrographic Methods," Bull. Amer. Assoc. Geol., 8, 1924, pp. 97-98.

and amount of concentrate per sample. Lithology must necessarily be stressed in correlations of the Tertiary sediments of the Gulf Coast since fossils are not present in all parts of the section.

CHAPTER III

MINERALOGICAL DETERMINATIONS AND RESULTS

Light Minerals--Texture of Grains

The results obtained in the work on the textures of sands of the lower Oakville, the Catahoula, and the upper Jackson (Fayette) in Fayette County are shown on Plate VI. Each graph represents a sample of sand. The graphs are arranged according to the formational sequence in the section reading from the bottom to the top as follows: Upper Jackson (Fayette), Catahoula, and Oakville. The outlines of the different graphs show textural differences. The quantitative expression of these differences is shown in percentage amounts of the several sizes of grains screened.[35]

Samples of the upper Jackson (Fayette) differ texturally from the overlying Catahoula and Oakville sediments. As shown by the graphs, the Jackson sands show greater uniformity in sizes of materials. Catahoula sands, on the other hand, show all the four possible textural extremes, regardless of position in the section. Hence, with the upper Jackson (Fayette) marked by a uniformity of material and the Catahoula characterized by a wide variation in texture, a break between these two horizons is apparent.

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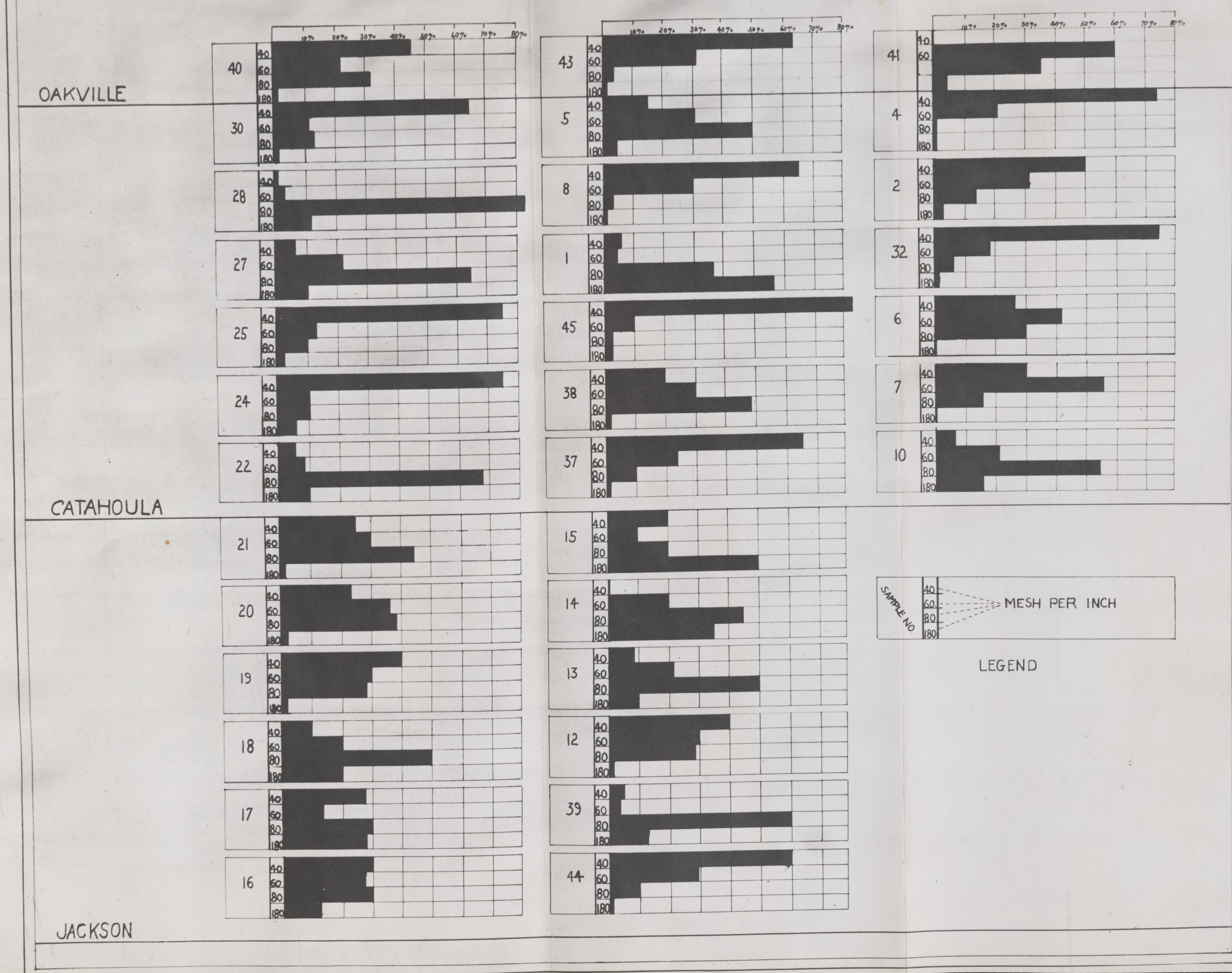
[35]Lonsdale, J. T., Metz, M. S., and Halbouty, M. T.: "Petrographic Characters of Some Eocene Sands from South West Texas," Journ. Sed. Pet., Vol. 1, p. 75.

TEXTURE

Pl. VI.



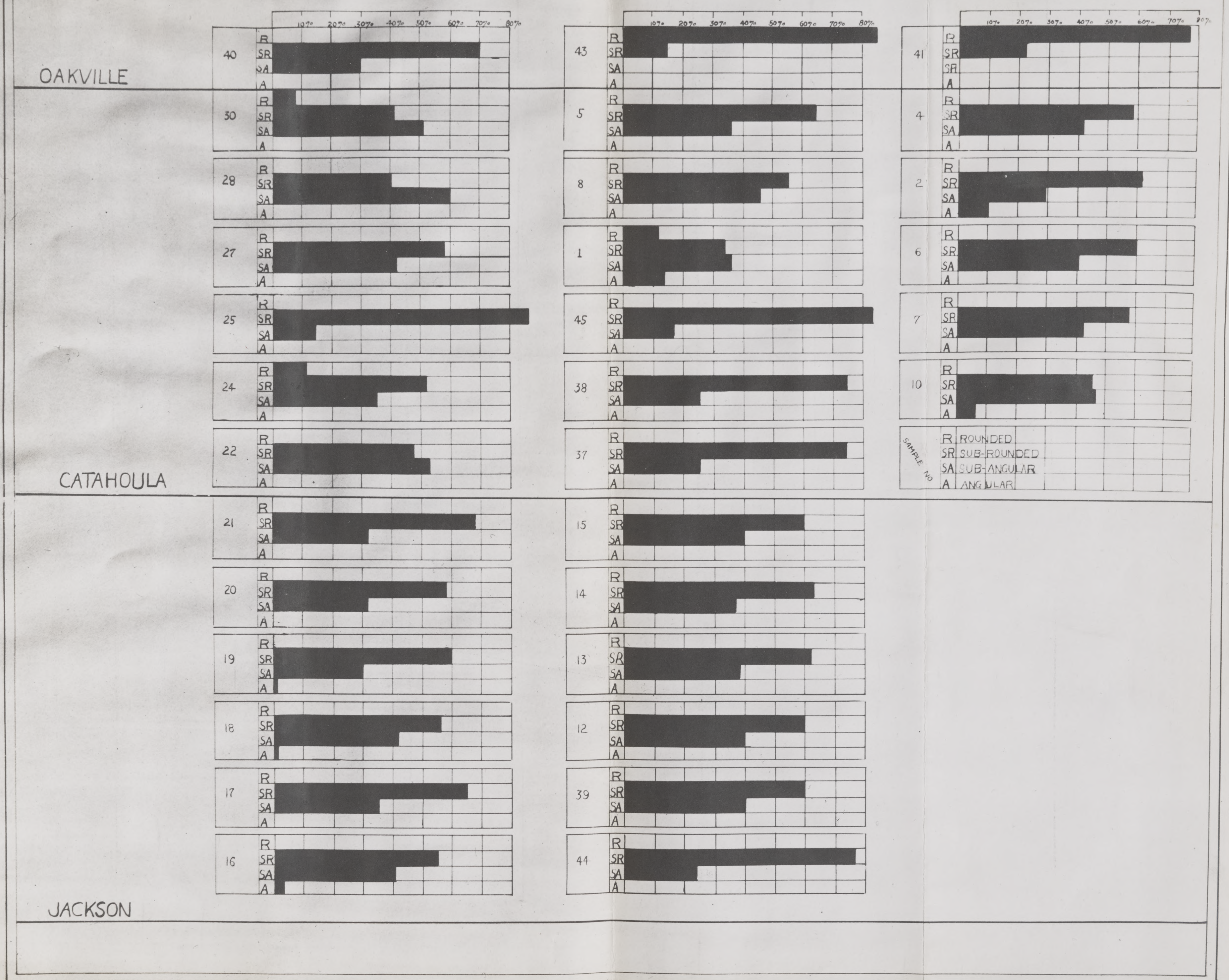
Shapes of Grains

Plate VII shows the results obtained from the investigation in the shapes of sand grains of the Catahoula, upper Jackson (Fayette), and basal Oakville. A marked similarity characterizes this whole group. Practically no rounded grains are found. The alteration of feldspars, or in other words, the decomposition of the feldspar constituents accentuates rounding in that the more rotten and softer grains are affected more by weathering than the harder, more resistant quartz grains. Hence, some apparent rounding is observed. The fragments examined show mostly sub-rounded to sub-angular characteristics. Well rounded grains are rare while angular grains are quite common, although in most samples they are present in only small quantities. Differences that are apparent in these determinations are not important diagnostically. Apparently these sands suggest a similar depositional history, although, as shown above, the Jackson (Fayette) is texturally more uniform than either the overlying Catahoula or Oakville.

Light Mineralogical Content

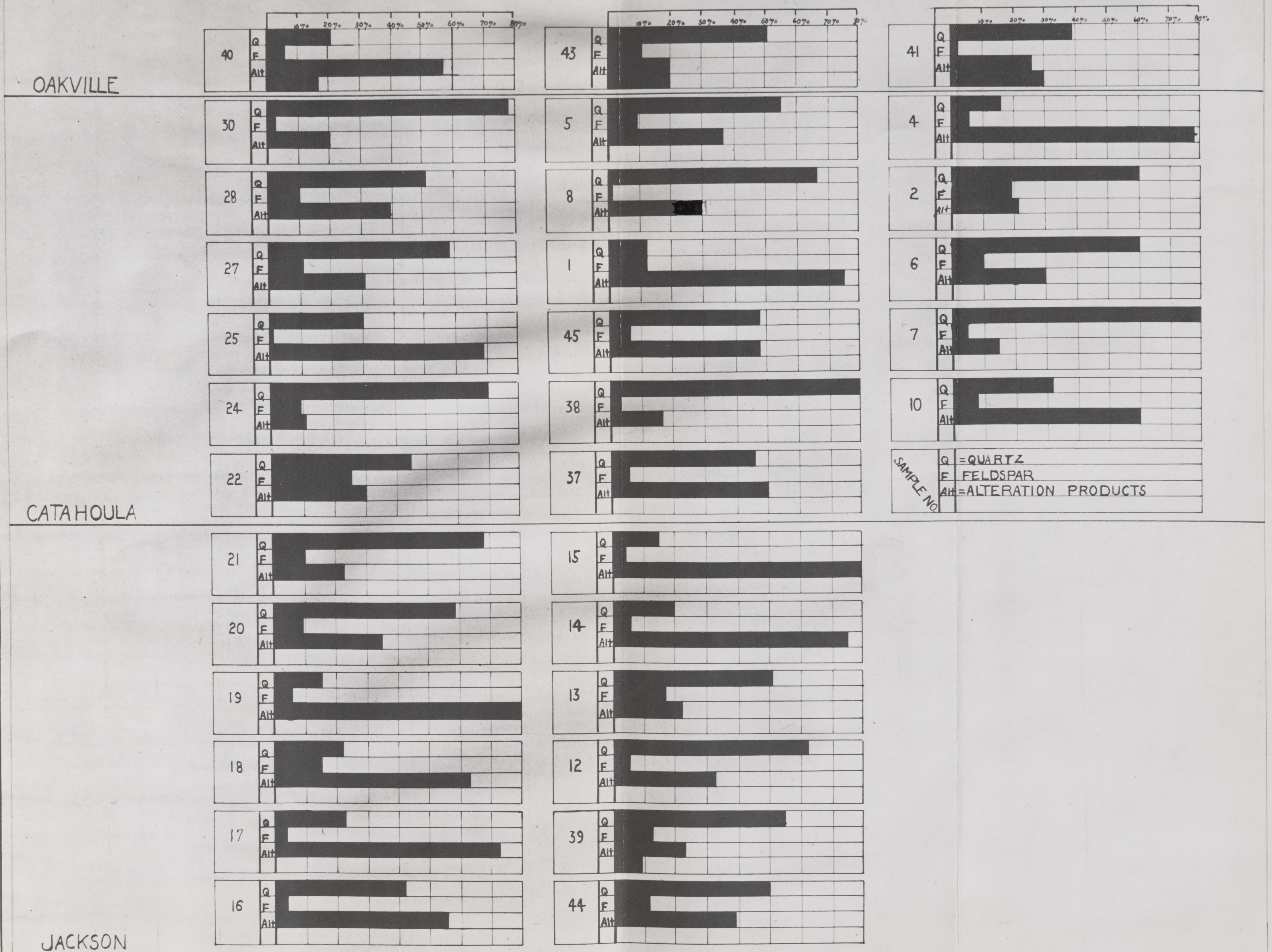
The light minerals of the Catahoula, except for a few exceptions in local lenses or pockets, are similar in all samples examined. (See graphs, Pl. VIII.) Quartz, microcline, and plagioclase are the chief constituents. Alteration constitutes about 40% of the total material examined. Some quartz grains show stress and strain effects, the majority of the quartz grains, however, are of the normal type.

SHAPE


OAKVILLE
CATAHOULA
JACKSON
10% 20% 30% 40% 50% 60% 70% 80%
40
30
28
27
25
24
22
21
20
19
18
17
16
43
5
8
1
45
38
37
15
14
13
12
39
44
41
4
2
6
7
10
R
SR
SA
A
SAMPLE NO
R ROUNDED
SR SUB-ROUNDED
SA SUB-ANGULAR
A ANGULAR

LIGHT MINERALS

Pl. VIII



Apparently microcline and orthoclase occur more abundantly and with greater persistence than the plagioclases in the samples examined. The feldspars that are fresh and unclouded often show determinable characteristics. Roughly, more alteration is found in the upper Jackson (Fayette) than in the Catahoula. The graphs, however, show a variable condition with respect to light mineralogical content of these two formations, but, from a correlative standpoint, it is of no value. The Oakville unconformably overlying the Catahoula contains lime and coquina debris deposited concurrently with the highly cross-bedded, coarse-grained Oakville sands and conglomeratic materials.

Alteration in the samples examined consists of (1) feathery grey to white material, (2) a cryptocrystalline material, and (3) a light brown to dark brown resinous earthy material. This alteration usually covers the grains beyond recognition, regardless of the variety. Frequently, however, feldspathoid characteristics can be determined on altered grains, if the alteration is not too dense. Microcline, especially, is easily recognized by its characteristic twinning.

Heavy Minerals

The chart, Plate IX, shows minerals identified from about sixty separations. Each sample is numbered and tabulated according to formation. Except for the well samples, of which about fifteen are included in this list, no elevations were obtained where the samples were collected; hence it is impossible to present a graphic section. Also, these materials were collected in different parts of the county along

HEAVY MINERALS

Formation and Sample Number	Magnetite	Limonite	Zircon	Ilmenite	Pyrite	Leucoxene	Kyanite	Tourmaline	Rutile	Cordierite?	Epidote	Staurolite	Monazite	Biotite	Serpentine	Muscovite	Spinel	Garnet	Anatase	Titanite	Brookite	Calcite	Hornblende	Glauconite
OAKVILLE																								
49	A	A	C	C			R																	
9	/																							
43	A	A	C											C										
42		C	A	C		C					R												R	
CATAHOULA																								
46	A	A	A	C				C			C	R		C		R								
52	A	A	C	C			K					K	R	C				G						R
54	A	A																						
45	A			A	C		R					R						C						
37	A		C	A	C				R			R	R											
38	A	A	A	C			C	C	R		R			C					R					
62	A	A	C											C				R						
34	A	C	A	C			R				R			C									R	
33	C	R	A	C	A			R					R	C				R						
32	C	C	A		A								R					R						
31	C	C	A		A		C	R	R		R													
29	A		A		C			R		C?		R												
28	C	C	A		A			R	R					C										
27	C		C		A			R			R		C	C										
25	C		C		A						C													
24	A	C	C		A		R				R		R										R	
4	A	A	A						R		R		R	C	R		R							
65	A	A	C	C				R			R			C						R				
8	A	C	A	C			C	R	R	R	R	R												
58	A	A		C	C			C				R		C				R						
5	A	C	A	C	R		R	C	C	R				R	R				R		R?			
10	A	C	A				C	C	R	C				C	C		C	R	R					
57	A	C	A	A			C					C		C									R	
7	A	A	A	C			C	C	R		R			C										
68	R	A	R	C																				
40	A	A	A	C			C	C			C	R						R				C		
48	A	C	C	C			C	R																
6	A	C	A	C			R	R	C										R					
2	A	A	A	C			C	C	R	R	C		R	C		C			R	R				
JACKSON																								
22	C	C	A	R			R	C	R	R?			R	C			R	R			R	C	R	
60	A	A	R				R							C		A								
21	A	C	A	C	C									A										
20	C			C	A			R						C				R						
39	A	A	A	C	C			R								C							R	
19	A	A	C	C	C									C									R	
44	A	A	A	C																				
18	A	C	A	C			R				R		R	C			R	R						
17	A	C	A	C	C		C	R	C	R?				R		C	C							
16	A	A	A	C	C		R	R					R	C				C	R					
15	C	C	A	C	C					R?			R?											
14	C	C	A		C		C	C	R				R	R			R?	R						
13	A	A		C	R		C	C	C	C?	C		R	C		R	R	R	R?				R?	
12	A	C	A	C	C	R		R		C?			R	C		R		R	R				R	
11	C		A	C	A	C			R		C			C		R								

A = Abundant ; C = Common ; R = Rare

the Catahoula outcrop. The chart, therefore, shows only a generalized section of the Catahoula in Fayette and Washington counties, and it has no correlative significance.

Results obtained in this work can only be used as a sort of perspective for further work. Identifications of the minerals, it is believed, are reliable although some may have been overlooked.

Minerals that occur in the formations examined can be roughly placed into three groups. First, the abundant and persistent minerals, such as magnetite, zircon, limonite, and to some extent ilmenite. Second, the minerals that occur persistently but not very abundantly, such as tourmaline, kyanite, biotite, and to some extent epidote, muscovite, and rutile. The latter three, however, occur erratically and are often entirely absent. Third, the rare varieties which occur at random and in only very small quantities. For example, hornblende is found, but very scatteredly, throughout the whole section. No correlative value could possibly be attached to such occurrences, although with additional work it might be discovered to be in well defined zones which could be used for correlation.

Descriptions of Heavy Minerals

The following is a list of minerals identified in the upper Jackson (Fayette), Catahoula, and lower Oakville; Magnetite, Limonite, Zircon, Ilmenite, Leucoxene, Kyanite, Tourmaline, Rutile, Epidote, Staurolite, Manozite, Biotite, Serpentine, Muscovite, Spinel, Garnet, Anatase, Titanite, Brookite, and Calcite. These minerals are listed in their order of abundance. In identifying the constituents of the different concentrates Milner's work was found to be very satisfactory.[36]

In the following descriptions only the salient features of each mineral are given. For a complete description the text by Milner,referred to above, should be consulted.

Limonite

Limonite occurs in irregular powdery aggregates, frequently taking on a compact reddish appearance. A brown ochreous color is noticed in reflected light, but it is opaque in transmitted light. Limonite is present in nearly every sample of the Catahoula and upper Jackson (Fayette).

Magnetite

Magnetite in the Catahoula occurs as silver-gray, octehedral grains, as shiny black grains, and as black metallic grains. Minute facets on the grains are often revealed. Magnetite fragments are mostly angular, although rounded fragments are quite common.

Zircon

Zircon occurs as colorless, prismatic grains with pyramidal terminations and showing very little rounding. Inclusions are very common. Zircon is widespread and was found in every separation. No detailed correlative determinations were attempted.

Ilmenite

Ilmenite occurs as irregular, sub-angular grains, with a purple-grey or frequently sub-metallic luster in reflected light. It is opaque, many of the grains having partially altered to leucoxene; and it occurs quite abundantly in the upper Jackson (Fayette) and Catahoula of Fayette County.

[36] Milner, H. B.: <u>Sedimentary Petrography</u>, London, 1929, pp. 116-263.

Leucoxene

Leucoxene occurs as an alteration product on grains of ilmenite. It is fairly abundant, and can be used as criteria for identification of ilmenite. It is often associated with rutile.

Pyrites

Pyrite of the Catahoula and upper Jackson (Fayette) occurs as well crystallized dodecahedra, or "pyritohedra," the latter in complex penetration twins. Small cubic grains were found in three samples. Pyrite has a brassy-yellow color, and it is often tarnished with a limonitic alteration.

Kyanite

The Catahoula and upper Jackson (Fayette) kyanites are colorless; hence they show no pleochrism. Grains found in separations are elongated, ragged, and show high relief when immersed in an oil of 1.54 index of refraction. Some grains have good cleavage. Kyanite occurs persistently and often in considerable quantities.

Tourmaline

Tourmaline is a ubiquitous species and occurs principally as prismatic brown pleochroic grains. A few basal sections were found. Inclusions are often noted. No zoned grains were found. Brown tourmaline shows much stronger pleochrism than the blue varieties of which only a few grains were found.

Rutile

Rutile occurs in red and brown varieties, often showing geniculate twinning. It occurs as prismatic fragments with pyramidal terminations. Rounded grains of rutile are often noticed, although they are rare in proportion to the number of well-defined rutile crystals that are found.

Epidote

Epidote occurs in irregular and rather angular grains. The platy forms often show partial interference figures, showing the emergence of an optic axis. Grains are usually yellowish-green, and have a high birefringence.

Staurolite

Staurolite shows moderate pleochroism and has weak dispersion. Well crystallized forms in the Catahoula and upper Jackson (Fayette) are rare. It usually is a lemon-brown color, occurs in irregular grains, and is a hackly fractured. Inclusions are quite common. A cruciform twin was noticed. Staurolite occurs rather abundantly, although many samples show no traces of it at all.

Monazite

Monazite has a high index of refraction. It occurs as well rounded grains; frequently pale-yellow varieties are found. It can be distinguished from zircon by its egg-shaped appearance, and its broad intensely black band along the outer border in ordinary light. It occurs rather commonly in the Catahoula and the upper Jackson (Fayette) detritals.

Biotite

Biotite is pleochroic and gives pseudo-uniaxial interference figures. It occurs in brown, yellow, or green cleavage plates with ragged edges, although perfect basal hexagonal plates are common. Some fragments show partial alteration. It is diagnosed by its color, cleavage, and by its biaxial negative figure.

Serpentine

Serpentine is a green mineral with a low index of refraction, and some grains are faintly pleochroic. It is irregular in outline, and contains inclusions of iron ore. Serpentine is pseudomorphous, usually after olivene, although no olivene was observed.

Muscovite

Muscovite is found as thin platy grains. Only basal flakes were found. The mineral itself is colorless, gives good interference figures, and is easy to recognize. Inclusions are common.

Spinel

Spinel is optically isotropic and is usually colorless, although some reddish-pink varieties are common. It has a high index of refraction and is often found as irregular fractured grains. The reddish varieties are well rounded. Anomalous interference figures are shown by some fragments.

Anatase

Anatase is a yellow to yellowish-brown mineral, occurring in striated, tabular fragments. Inclusions are commonly found. Anatase is very rare, consequently no exhaustive determinations could be run, although it is easily recognized by its striated tabular form.

Titanite

Titanite has a high index of refraction and a very high birefringence. Only one or two fragments were found. No interference figures could be obtained; however, striae parallel to the principal axis were noticed.

Calcite

Calcite has a high birefringence, and it occurs as highly irregular grains. Twin striae are often noticeable, but it is diagnosed chiefly by its "twinkling" effect, which is noted upon the rotation of the stage in polarized light. The calcite of the Catahoula occurs as crystals in the nodular concretions which were precipitated out of seeping waters in crevices and holes.

Diatoms

Thin sections of the upper Jackson (Fayette) shale beds, immediately below the Catahoula-Jackson contact, contain diatoms. No extensive research was done on these fossils. Four slides of the upper Jackson (Fayette) shale material were made and each contained diatomaceous material.

The material consists of either globular or crescent-shaped tests, which are made up of a great number of minute apparently polygonal blocks. No attempt at identification was made.

No diatoms were noticed in the Catahoula sections.

Sandstones

Sandstones of the Catahoula that lend themselves to thin-sectioning are the lenses of a quartzose variety found at the base of the formation. These sands are cemented by a siliceous, glassy appearing medium, which is very hard and dense. Under the microscope the cement is mainly isomorphous, although some cryptocrystalline material is present. The shape of the grains ranges from predominantly angular in some samples to predominantly sub-angular in others. Quartz is the main constituent, with some orthoclase, microcline, and smatterings of plagioclase which was identified by its twinning. All grains are exceptionally clear and unclouded, showing very little alteration. Stress and strain effects are present.

The feldspar grains, which constitute about 15% of the total amount of material, are fresh and unaltered. This would indicate a short interval of exposure to weathering conditions. The angularity, which is so predominant in some of the sections, together with the unaltered feldspar would suggest a nearby land mass as the source of the sediments.

Glasses

Volcanic glasses occur in great abundance in the upper Jackson

(Fayette). A sandy ash bed at the top of the Jackson was examined which consists of large shreds of tabular glass full of blow holes. This horizon contains the largest grains of glassy material found in this area. However, only a few samples were run from each of the three known ash horizons of the Catahoula.

In the sections of the fine-grained glass material of the Catahoula microlites are common, comprising from 1% to 10% of the total mass. These microlites are imbedded, with shreds of feldspars and quartz, in an earthy to cryptocrystalline groundmass. A few sections show no glass whatever. The cryptocrystalline material is believed to be devitrified glass, although positive evidence is lacking.

Another noticeable feature in these clays or ashy materials is the variable size of both the quartz and feldspar grains.

Lime

The Catahoula is locally quite calcareous. Apparently, much of the lime that is present is of secondary origin, having been carried down in solution from the overlying limey sands of the Oakville. Lime found in the Catahoula consists of grey, either hard or soft, concretion-like nodules although the concentric structure of a typical concretion is lacking. The thin sections show a kernel of lime surrounded by isomorphous and cryptocrystalline mass of lime. Upon rotating the stage under x nicols dove-tailed extinction is apparent. In this solid semicrystalline matrix small grains of both quartz and feldspar are found.

Apparently these grains, included in the nodules, are just as abundant in the lime as they are in the surrounding mass in which the nodules are imbedded.

CHAPTER IV

PALEOGEOGRAPHY

The Catahoula is underlain by Jackson (Fayette) shales, laminated sands, and ash beds, some consisting of about 60% pure glass. This implies continental to semi-marine conditions when these materials were deposited. Sand grains in the upper Jackson are sub-rounded to sub-angular, which suggests deposition under aqueous conditions. All seem to be stratified to some extent. The argillaceous varieties, especially, are usually well laminated. Diatoms which are common in both the thinly laminated shales and the ash horizons suggest deposition in ponds and lakes.[37]

The upper Jackson (Fayette), therefore, represents an oscillating sea subjected to spontaneous volcanic ash deposition, probably above wave planation, which, upon the recession of the sea, resulted in the formation of ponds and lakes in which diatoms thrived. Then upon transgression of the Jackson sea, sands and later shales were deposited.

Heavy minerals identified, consisting of rutile, zircon, epidote, magnetite, garnet, biotite, leucoxene, limonite, monazite, pyrites, staurolite, etc., in themselves suggest either long erosional exposure or several cycles of erosion. Some of the minerals above of authigenic varieties suggest open formations through which percolating ground waters

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[37] Dumble, E. T.: "The Geology of East Texas," University of Texas Bull., 1869, 1918, p. 182.

can seep freely and re-deposit these secondary or authigenic constituents.[38]

Catahoula

The basal horizon of the Catahoula of Fayette County is a quartzose sandstone. The shapes of both quartz and feldspar grains in this sandstone range from angular to sub-angular to sub-rounded. Aeolian origin, except for beach blown conditions, is out of the question. Apparently these sands were deposited under sub-aqueous conditions.[39]

Steep and complex cross-bedding in some of these sands suggest continental deposition. This phenomenon, however, occurs only locally and often massive horizontal bedding is noticeable in this basal sand horizon.[40]

Therefore, from a physical point of view, this suggests rather shallow depositional conditions. According to Mr. Carroll Cook[41] the basal Catahoula changes laterally to the southwest into a conglomeratic horizon, opalized wood being one of the constituent materials. The basal Catahoula, therefore, is believed to have been deposited upon low coastal lands and their continuations in deltas and lagoons.[42]

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[38] Milner, H. B.: Sedimentary Petrography, London, 1929, pp. 425-451.

[39] Sherzer, W. H.: "Criteria for the Recognition of the Various Types of Sand Grains," Geol. Soc. Am., 21, 1910, p. 625.

[40] Kindle, E. M.: "Cross-bedding and Absence of Fossils Considered as Criteria of Continental Deposits," Am. J. Sc., (4), 32, pp. 225-230, 1911.

[41] Mr. Carroll Cook made this observation while doing stratigraphical work on the Catahoula in Gonzales County, Texas, in 1932.

[42] Dumble, E. T.: "The Geology of East Texas," Univ. Texas Bull., No. 1869, 1918, p. 183.

Heavy minerals found in this basal sand are practically all of the stable varieties. Zircons are angular, although rounded grains in small quantities are present; magnetite is very abundant; tourmaline is present; rutile twins are not uncommon; epidote, ragged kyanite, and isotropic garnet were also found. In other words, the basal member, mineralogically, bears a resemblance to the underlying upper Jackson (Fayette) sands. However, a greater uniformity of size of the mineral grains seemingly prevails in the lower Catahoula. As mentioned before, these mineral assemblages consist mainly of the stable varieties which can withstand several erosional cycles.

In thin sections these sands show from 10% to 25% of fresh unaltered feldspars. As mentioned above, this phenomenon suggests mechanical disintegration of the parent rock, and with no alteration taking place subsequent to deposition.[43]

In connection with the constituents of these sands the cementing medium must be considered. It consists of isomorphous silica as hard and nearly as resistant to weathering as the constituent grains. This being true, the freshness of the constituent feldspars may be partly explained, i. e., the weathering and disintegration of the feldspars was limited, in time, to the period of mechanical disintegration, transportation, and deposition of the feldspars.

Sands above the basal member of the Catahoula are unconsolidated

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[43] Goldman, M. I.: "Petrographic Evidence on the Origin of the Catahoula Sandstone of Texas," Am. J. Sc., (4), 39:187, 1915, Q. I.

or loosely cemented with argillaceous or ashy material. Feldspars are usually altered beyond recognition. This alteration consists of three rather distinct varieties: (1) a cryptocrystalline material, (2) a whitish covering of the grains, and (3) a light-brown to dark-brown resinous earthy material. The latter by far exceeds the former. Paleogeographically, this suggests either a far source of materials with probably intermediate transportational stops, or a deposition of fresh feldspar derived from some nearby parent rock with subsequent alteration taking place. The latter appears plausible for several reasons which are as follows:

1. The source of both the basal and upper sands in the Catahoula should be theoretically the same since no hiatus is noticeable, with the exception of a few local unconformities.

2. The basal sands were cemented upon deposition, as a result, no subsequent alteration of the constituent feldspars took place.

3. The upper sands are unconsolidated, the few that are cemented having been impregnated subsequently by the precipitates of percolating water.

4. These percolating waters react continually on the fresh or partly altered feldspars, hence the great amount of alteration.

5. The above may be summarized as follows: The basal sands are closed to percolating waters, hence no alteration; the upper sands are continually subjected to seeping waters and as a consequence there is a great amount of alteration.

Heavy minerals in the upper sands of the Catahoula apparently decrease both in quantity and variety as compared with the lower beds. Pyrite, zircon, and magnetite horizons are abundant; tourmaline, kyanite, biotite, muscovite, etc., are generally present. No theory as to the source of these sands can be postulated from the above mineral suites, although the author realizes that upon further research the origin of these sands may be determined.

Tuffs of the Catahoula consist of a small percentage of pure glass, devitrified glass in the form of cryptocrystalline material, earthy isomorphous materials, and a variable amount of quartz and feldspar shreds. No evidences of stratification are shown in the arrangement of the quartz and feldspar shreds. This heterogeneous arrangement of shreds suggests rapid deposition of the tuffs. The Catahoula tuffs of Fayette County are acidic, and probably were deposited in shallow waters as further substantiated by lensing and cross-bedding. Apparently the origin of these volcanic tuffs is from the southwest.

Bailey, in his paper on the "Gueydan of Southwest Texas," describes primary volcanic boulders.

No boulders consisting of volcanic material were found in the Catahoula of Fayette County. Apparently only particles classed as volcanic dust were deposited in this region. Hence, it follows that Fayette County was farther away from the source of the materials than the area described

[44] Bailey, T. L.: "The Gueydan, A New Middle Tertiary Formation from the Southwestern Coastal Plain of Texas," Univ. Tex. Bull., 2545, 1926, pp. 85.

by Bailey to the southwest.

CHAPTER V

SUMMARY

1. Stratigraphically the Catahoula is placed in the lower Miocene and rests unconformably upon the upper Jackson (Fayette) of upper Eocene age.

2. Light mineral investigations: (1) texturally the upper Jackson (Fayette) sediments show great uniformity of size while the Catahoula materials are characterized by a wide variation in texture; (2) in shapes of grains a marked similarity characterizes both the upper Jackson (Fayette) and the Catahoula sediments; (3) in mineral composition, including the quartzose member in the basal Catahoula, the sediments studied consist of quartz, feldspars, and alteration products of feldspars.

3. The basal quartzose sandstone of the Catahoula, in thin sections, shows an extreme angularity of both quartz and feldspar grains, the latter showing very little alteration.

4. Catahoula volcanics are almost totally devitrified, while the Jackson (Fayette) ash beds are characterized by pure glass.

5. The heavy minerals of the upper Jackson (Fayette) and the Catahoula consist of the common resistant and authigenic varieties, and can be divided into three general groups: (1) the abundant varieties, (2) the common and rare but persistent varieties, and (3) the rare sparsely occurring varieties.

PLATES

PLATE X

Fig. 1: Tourmaline crystals from Fayette County, Texas, showing their prismatic habits and pleochrism. Magnified 28 diameters.

Fig. 2: Zircon crystals from the basal Catahoula, Fayette County, Texas, showing their prismatic habits, pyramidal terminations, and some rounding. Magnified 28 diameters.

Fig. 3: Staurolite fragments from the upper Jackson, Fayette County, Texas, showing their irregular habit of occurrence. Magnified 84 diameters.

Fig. 4: Rutile from the Catahoula, Fayette County, Texas, showing prismatic habit of the mineral and the somewhat rounded irregular termination of the grains. Magnified 84 diameters.

Pl. X.

Fig. 1

Fig. 2

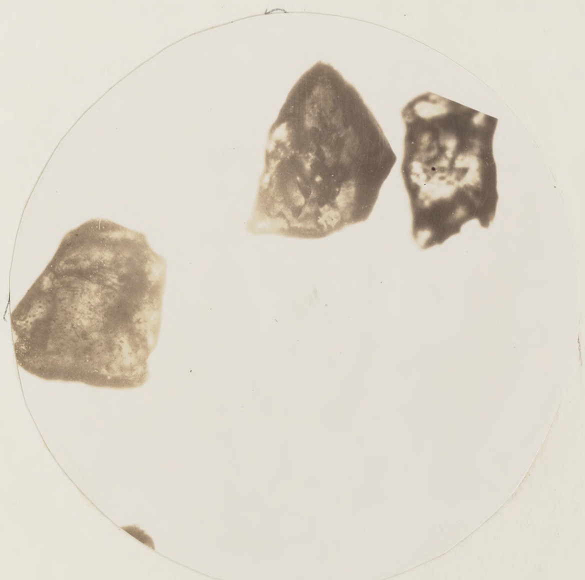
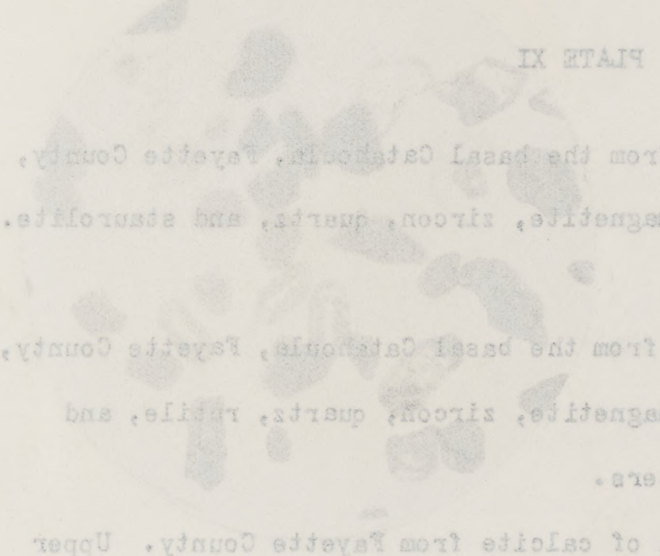


Fig. 3

Fig. 4



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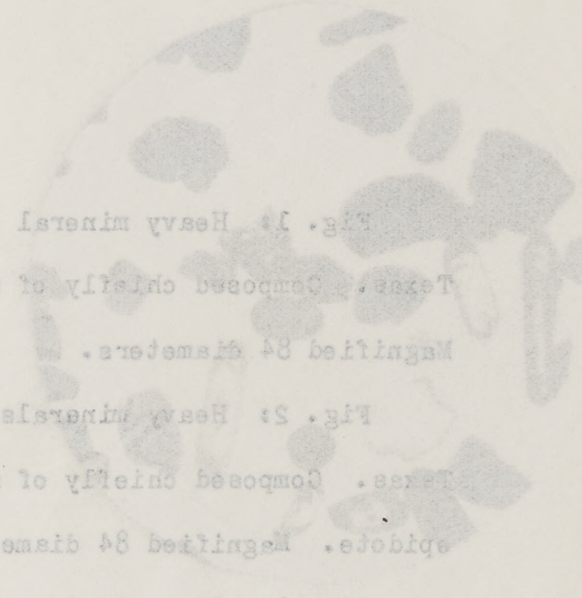

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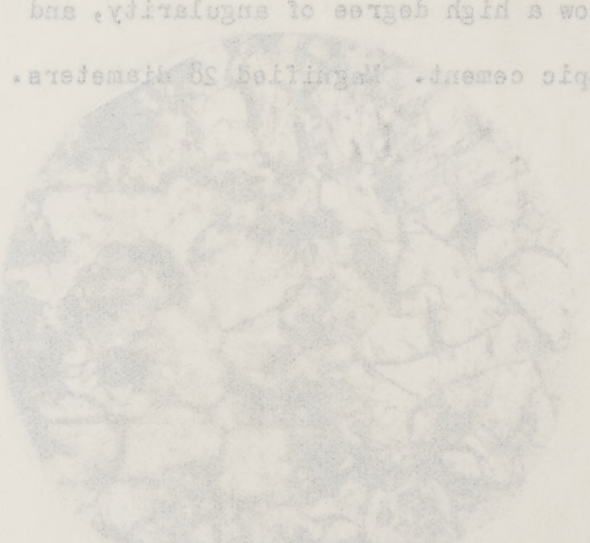

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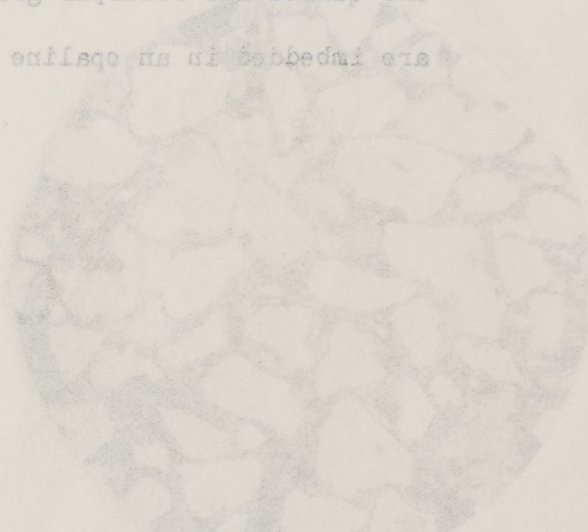


Fig. 4

PLATE XI

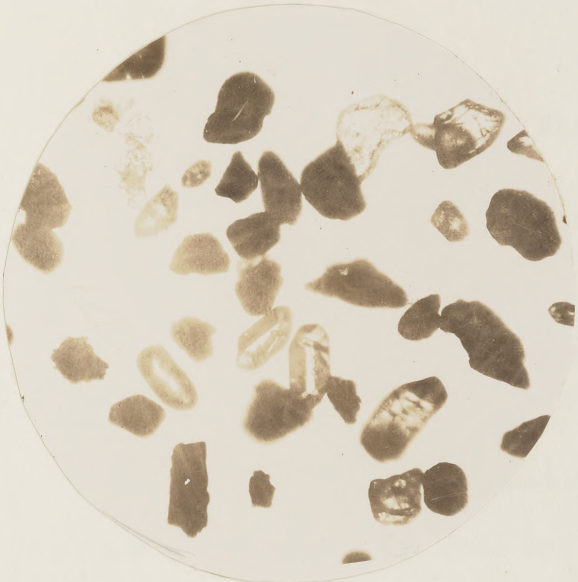
Fig. 1: Heavy mineral from the basal Catahoula, Fayette County, Texas. Composed chiefly of magnetite, zircon, quartz, and staurolite. Magnified 84 diameters.

Fig. 2: Heavy minerals from the basal Catahoula, Fayette County, Texas. Composed chiefly of magnetite, zircon, quartz, rutile, and epidote. Magnified 84 diameters.

Fig. 3: Photomicrograph of calcite from Fayette County. Upper Catahoula. Magnified 28 diameters.

Fig. 4: Photomicrograph of a basal Catahoula quartzose sandstone. The quartz and feldspar grains show a high degree of angularity, and are imbedded in an opaline isotropic cement. Magnified 28 diameters.

Pl. XI



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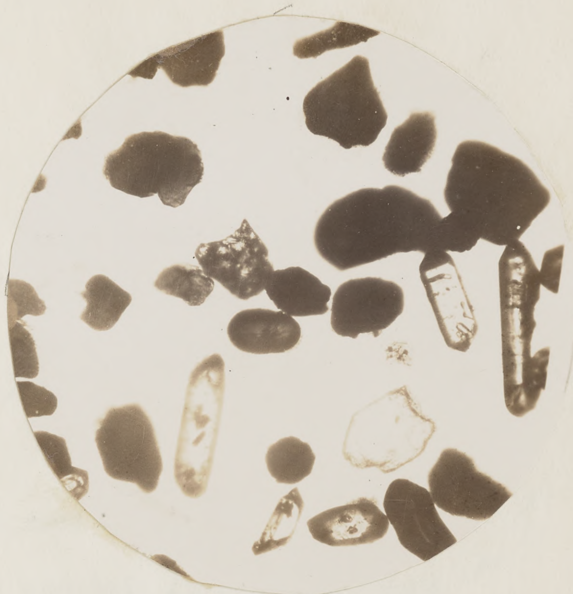

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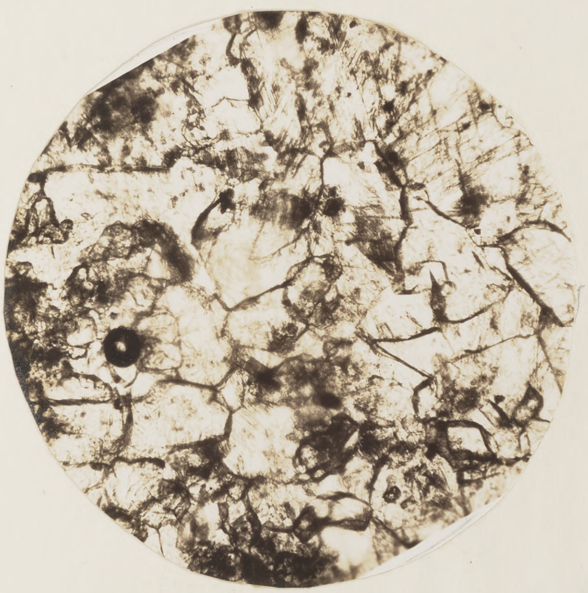

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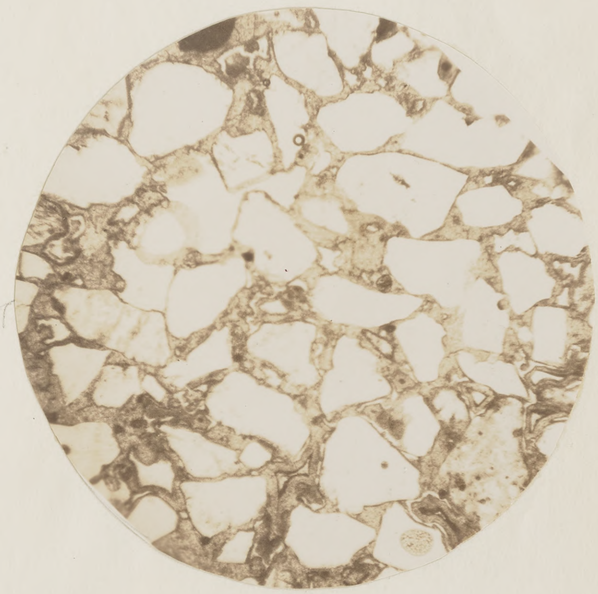

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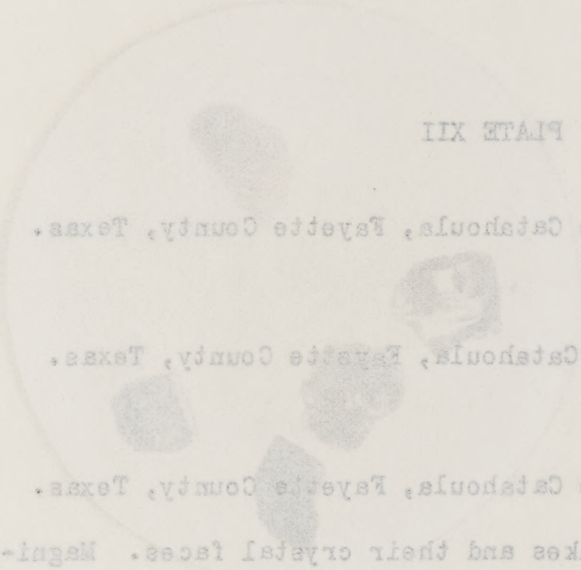
Pl. XII.



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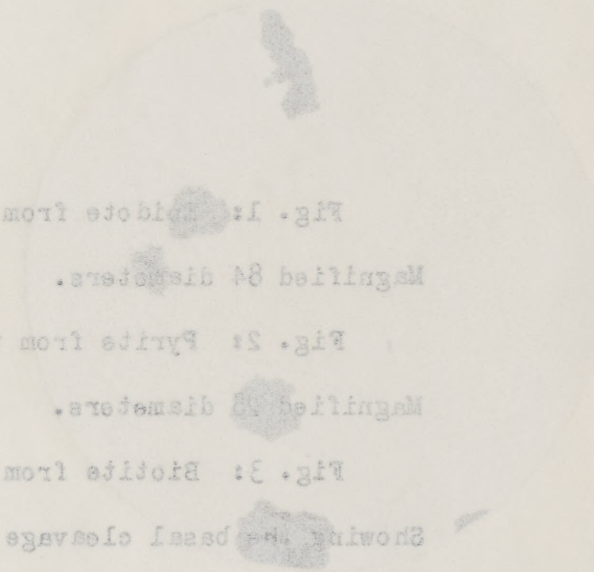

Fig. 3

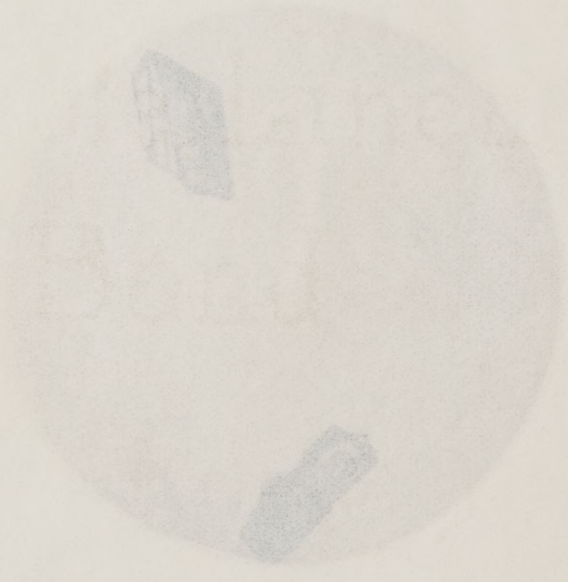

Fig. 4.

PLATE XII

Fig. 1: Epidote from the Catahoula, Fayette County, Texas. Magnified 84 diameters.

Fig. 2: Pyrite from the Catahoula, Fayette County, Texas. Magnified 28 diameters.

Fig. 3: Biotite from the Catahoula, Fayette County, Texas. Showing the basal cleavage flakes and their crystal faces. Magnified 28 diameters.

Fig. 4: Kyanite from the Catahoula, Fayette County, Texas. Magnified 84 diameters.

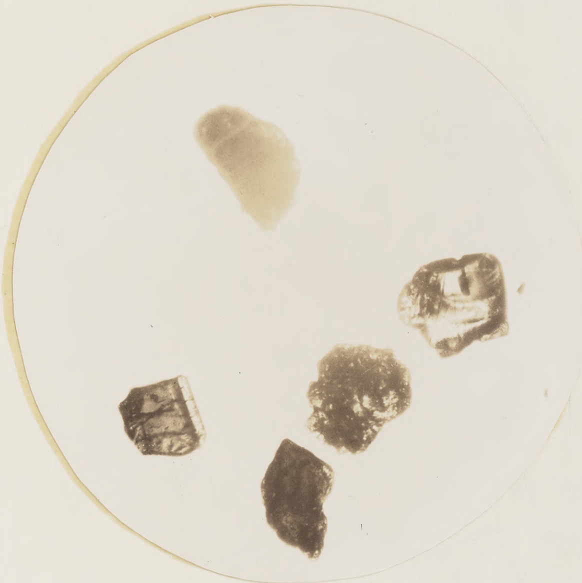

Fig 1

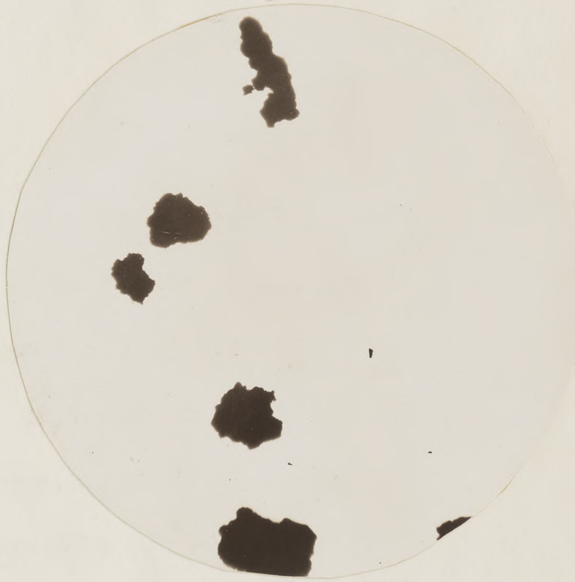

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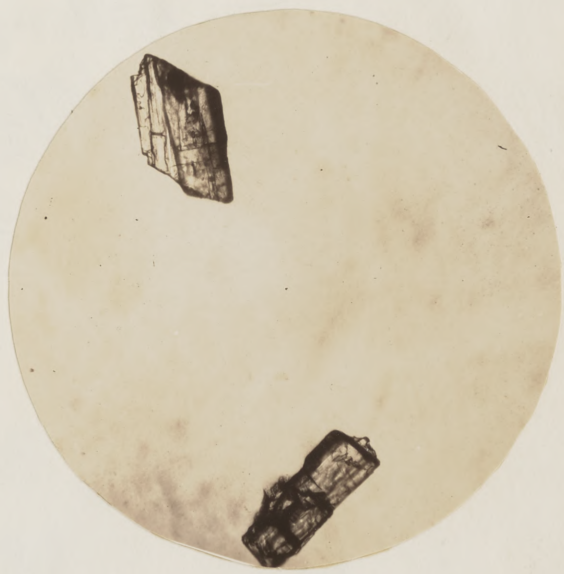
Fig. 3



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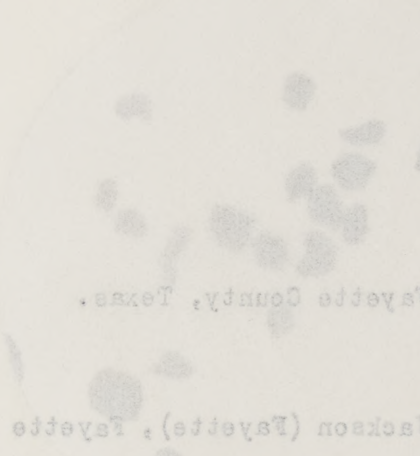

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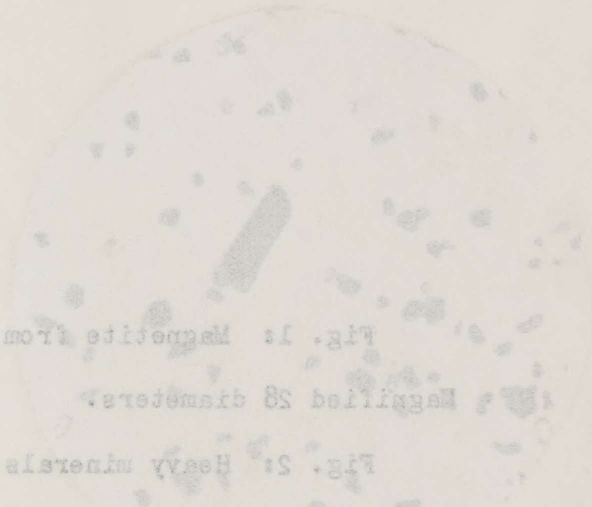

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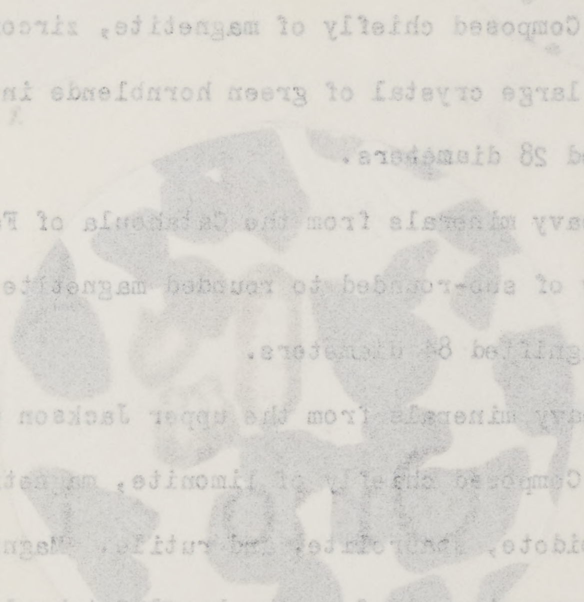

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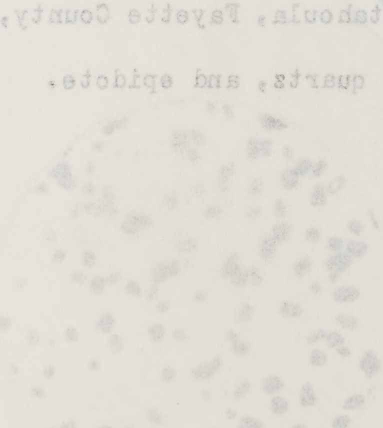

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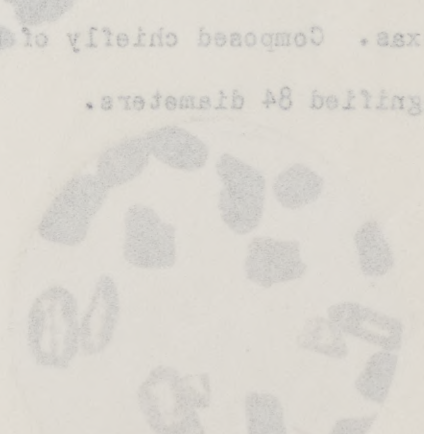

Fig. 5

PLATE XIII

Fig. 1: Magnetite from the Catahoula, Fayette County, Texas. Magnified 28 diameters.

Fig. 2: Heavy minerals from the upper Jackson (Fayette), Fayette County, Texas. Composed chiefly of magnetite, zircon, kyanite, quartz, rutile, and one large crystal of green hornblende in the center of the field. Magnified 28 diameters.

Fig. 3: Heavy minerals from the Catahoula of Fayette County, Texas. Composed chiefly of sub-rounded to rounded magnetite, zircon, monazite, and epidote. Magnified 84 diameters.

Fig. 4: Heavy minerals from the upper Jackson (Fayette), Fayette County, Texas. Composed chiefly of limonite, magnetite, zircon, tourmaline, quartz, epidote, staurolite, and rutile. Magnified 28 diameters.

Fig. 5: Heavy minerals from the basal Catahoula, Fayette County, Texas. Composed chiefly of magnetite, zircon, quartz, and epidote. Magnified 84 diameters.

Pl. XIII

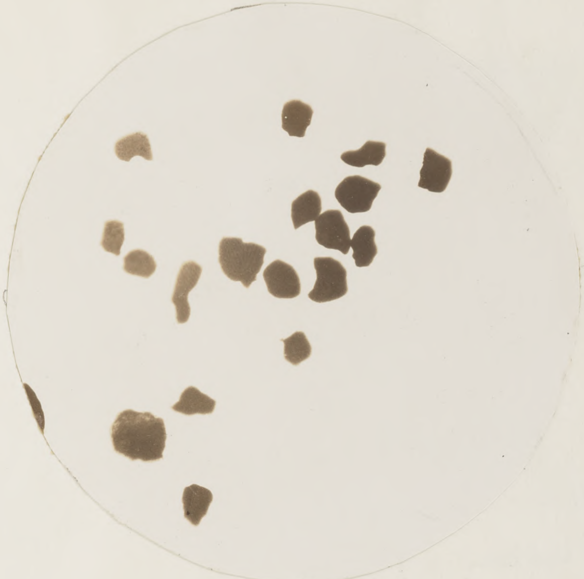

Fig. 1.

Fig. 2.

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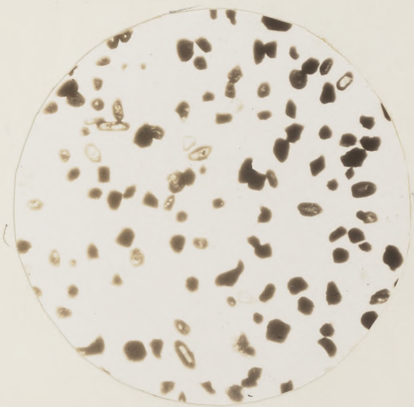

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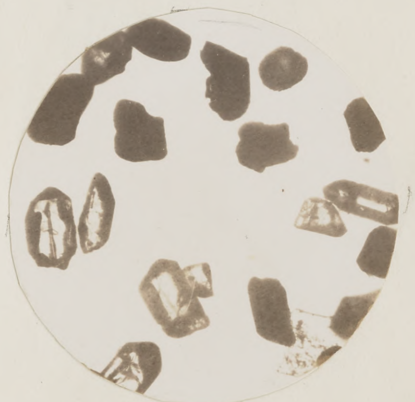

Fig. 5

Pl XIV

Fig. 1. Fresh-water fossils [redacted] in the basal Catahoula, about 3 miles south of Nechanitz, Fayette County, Texas.

PLATE XIV

Fig. 2. The Catahoula-Oakville contact, about 3 miles south of La Grange, Fayette County, Texas.

Pl. XIV.

Fig. 1. Fresh-water fossils [redacted] in the basal Catahoula, about 3 miles south of Nechanitz, Fayette County, Texas.

Fig. 2. The Catahoula-Oakville contact, about 3 miles south of La Grange, Fayette County, Texas.

Fig. 1. Jackson laminated shale and sands southwest of La Grange, Fayette County, Texas.

PLATE XV

Fig. 2. Basal Catahoula cross-bedded sandstone, 1 mile south of Nechanitz, Fayette County, Texas.

Pl. XV.

Fig. 1. Jackson laminated shale and sands southwest of La Grange, Fayette County, Texas.

Fig. 2. Basal Catahoula cross-bedded sandstone, 1 mile south of Nechanitz, Fayette County, Texas.

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The following references to literature incorporate those used in this paper and many additions dealing with sedimentary petrography, with special emphasis placed on heavy minerals. Every reference to literature given in this bibliography may be found in the University of Texas Library. Although this list of published articles on sedimentation is not intended to be exhaustive, the writer has included all the English and American references on heavy minerals available in the University of Texas Library.

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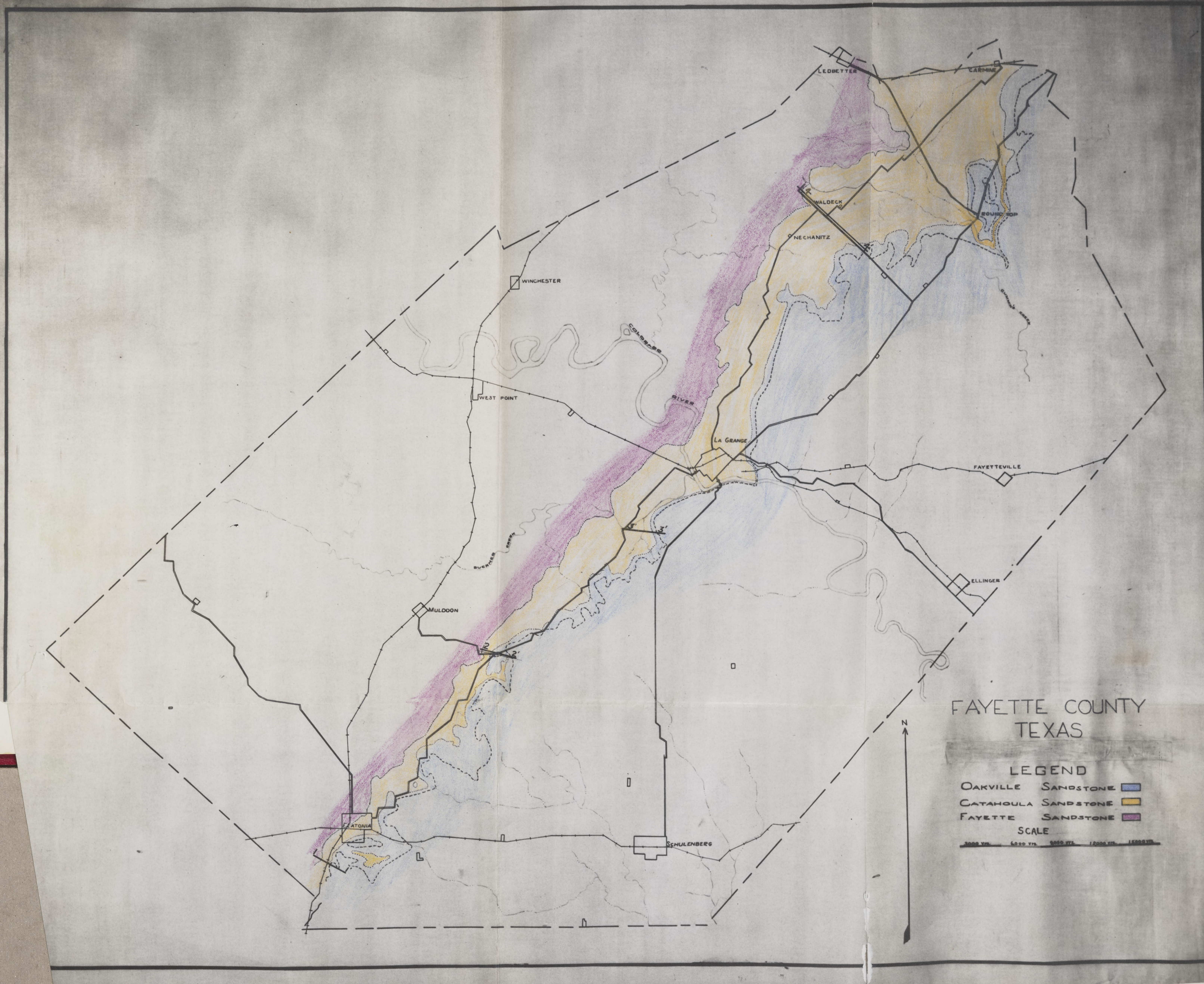
FAYETTE COUNTY
TEXAS
LEGEND
OAKVILLE SANDSTONE
CATAHOULA SANDSTONE
FAYETTE SANDSTONE
SCALE
3000 Vrs.
6000 Vrs.
9000 Vrs.
12000 Vrs.
15000 Vrs.
N
LEDBETTER
CARMINE
WALDECK
ROUND TOP
NECHANITZ
WINCHESTER
COLORADO RIVER
WEST POINT
LA GRANGE
FAYETTEVILLE
ELLINGER
MULDOON
SCHULENBERG